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DEER AND ELK HABITATS IN COASTAL FORESTS OF SOUTHERN BRITISH COLUMBIA

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ERRATA

Cover: "*NOVEMBER 1990*" should read "OCTOBER 1990".

Page v, line 39: "*...Line Giguere, and Ron McLaughlin*". should read "...Line Giguere, Ron McLaughlin, and Joan Voller".

Page v, line 41: "*...Ron Diederichs, Andrew Harcombe...*" should read "...Ron Diederichs, Paul Diggle, Don Doyle, Andrew Harcombe..."

Page x and page 68: The caption for Figure 46 should read "Current distribution of Roosevelt elk in British Columbia".

Page 82, Figure 57: " *= upper critical temperature*" and " *= lower critical temperature*" should read "U = upper critical temperature", and "L = lower critical temperature", respectively.

Page 210, lower figure: The legend should show the Ecoreserve pattern as solid dark green, not pale orange.

Deer and Elk Habitats in Coastal Forests of Southern British Columbia

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Preface

Since integrated management of British Columbia's resources became a provincial goal in the mid-1970's, land managers have struggled to achieve the optimum production of wood and wildlife from Crown forests. Little information has been available to explain how the management of forest stands and wildlife can be combined, and joint objectives for both resources have seldom been stated. Confusion and confrontation have often resulted. Although there is much knowledge that could aid integration of the management of timber with deer and elk, that knowledge has not been summarized in a format managers can easily use. This handbook is intended to provide, in one document, most of the information managers need to understand the interactions of forests, elk, and deer on British Columbia's south coast.

Improved management is needed because both wildlife and timber have high production potentials and demand from users is strong, but conflicts over land use are common. Coastal British Columbia provides the province's most productive deer habitat, and the only habitat for Roosevelt elk in Canada. It also has the country's most valuable stands of timber and its most productive growing sites. Logging and silvicultural activities affect a huge area each year. In the Vancouver Forest Region, for example, over 1000 km^2 were treated during the 1987-88 fiscal year alone (B.C. Ministry of Forests and Lands 1988). The harvesting and renewal of forests influence deer and elk populations greatly because the animals rely on forest vegetation for most of their requirements of life, including food and shelter. Some timber management practices, depending on where, when, and how they are applied, can damage habitat and reduce elk and deer populations. Other practices can improve habitat. Wildlife and forest managers, therefore, face important challenges in planning timber management programs that recognize deer and elk needs. Attempts at integrated management have often failed to resolve problems or exploit opportunities, however, because advocates of wildlife and timber could not agree on objectives or a management strategy.

Both government and the public want more from their forests and their resource managers. Provincial legislation governing the purposes and management of Crown forest land makes it clear that the provincial government expects good integrated management of forests and wildlife. Public concerns over the current state of resource management are heard loudly and clearly during opinion polls, such as those conducted for the Canadian Forestry Service (Decima Research 1986) and MacMillan Bloedel Limited (Goldfarb Consultants 1987). Yet, since the early 1970's, few modifications have been made to methods used to plan the management of wildlife habitat and timber. Change is long overdue.

We believe the most appropriate first steps toward that change are to improve communication between timber and wildlife managers, and to increase their understanding of timber and wildlife interactions. For too long, responsibility for the various aspects of timber and wildlife management has been left to specialists — logging managers, silviculturists, and biologists — occupying enclaves of separate objectives and knowledge. Now, managers of wildlife and timber must work together to develop co-operative solutions; or at least to understand the reasons why no such solution is possible in some situations. They need a common language, a shared understanding of the forestry options available to them, and a commitment to work together to improve techniques.

This handbook offers a seed from which co-operative solutions can grow. This seed needs to be watered by training and demonstration, warmed by frequent use, and fed by constant testing and improvement. Some critics may say this is still not enough, that we cannot have better forest wildlife management without new laws, further research, more regulations, more staff, and more money. No doubt all of these would help. In the meantime, however, we think existing knowledge could be put to better use.

Timber management and silvicultural programs are expanding in scale and sophistication every year, with increasing impacts on deer and elk habitats. Improvements in integrated management cannot come too soon. Jack Ward Thomas (1979, p. 19), in describing the need for a wildlife habitat handbook for the Blue Mountains of Oregon and Washington, said it best:

> *Some will say it is too soon to undertake such a task, but there are really only two choices — too soon or too late. With intensified forest management, impacts on wildlife will be magnified. The need is critical. The time is now.*

Land managers feel few qualms about acting on imperfect information, because they usually have no other choice. As Carl Walters (1986, p. 159) put it:

> *... resource managers must learn to live with some very substantial uncertainties.... This means in the end that many key management decisions are essentially* **gambles***.... Most people find it rather uncomfortable at first to think of resource decision making as gambling.... Indeed, when uncertainties are revealed in public debates it is often argued that inaction (wait and see, do more research) is preferable to the indignity of gambling; such arguments can reflect gross confusion between personal ethics (gambling as a personal weakness or bad habit) and public responsibility.*

Armed with information from the chapters that follow, managers of elk, deer, and timber will at least know the odds when they fulfill their public responsibilities by "playing their cards."

No matter how effective it is, though, this handbook cannot solve all of our timber-wildlife problems. Lack of clear policies and objectives for integrated production of timber and wildlife continues to hinder improved management. So does the problem of how to compare the societal value of resources as different in their natures and uses as wildlife and timber are. In addition, the book applies to only a small part of the province, and to only two wildlife species. It is a starting point, not the end of the issue.

This book contains the best that this group of authors can offer to provide guidance and stimulate new ideas. It is not full of answers, guidelines, or prescriptions (since there are no simple answers to most wildlife-timber questions). Rather, it presents facts, relationships, and procedures that are designed to be clear and useful in day-to-day management of coastal forest habitats. Although it can serve as an educational text for staff new to the coast or to the business of integrated management, the book's greatest value will be in helping experienced and imaginative managers to develop new solutions to old problems.

But it **is** only a tool. If left unused, the book will achieve nothing. There is, thankfully, no shortage of qualified people with the concern, the will, and the energy to make integrated management of elk, deer, and timber a reality. We hope this book will find a welcome place in their hands.

Brian Nyberg
Doug Janz
Technical Editors

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Chapter 1
Introduction

by
J.B. Nyberg, D.W. Janz, R.B. Addison,
R.D. Forbes, and E.L. Richardson

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  A Note on Terminology 29

In the last 20 years, land managers and the public in British Columbia have become increasingly concerned about the effects of timber management programs on non-timber resources such as wildlife. Nowhere is the interest in interactions between forestry and wildlife greater than on the south coast. On Vancouver Island and the adjacent mainland, highly valuable timber and thriving populations of Columbian black-tailed deer (*Odocoileus hemionus columbianus*) and Roosevelt elk (*Cervus elaphus roosevelti*) often occupy the same land areas (Figure 1). Logging and silvicultural activities yield a mixed bag of beneficial and detrimental changes in deer and elk habitats. Wildlife and forest managers have struggled for years to develop integrated management programs for timber and wildlife that would minimize negative effects and capitalize on positive ones, but success has been limited to date (Nyberg *et al.* 1989).

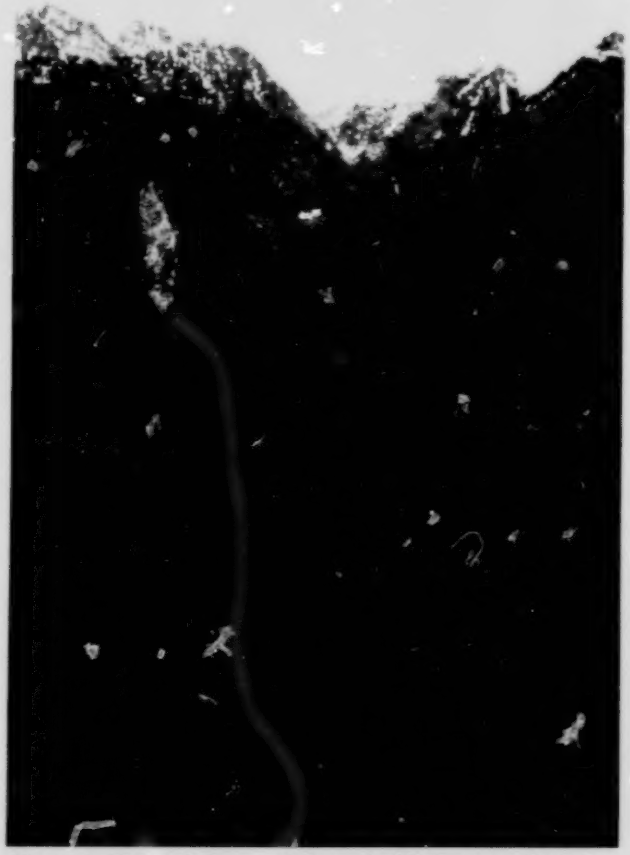

Figure 1. The varied topography and mild climate make the south coast highly productive for both forests and wildlife.

The goals for the management of Provincial Forests show clearly that both timber and wildlife are important and desired products of public lands. Section 5(4) of the Forest Act (RSBC Chapter 140, 1979) directs that Provincial Forests be managed and used for:

(a) *timber production, utilization and related purposes;*

(b) ***forage production and grazing by** livestock and **wildlife**;*

(c) *forest or wilderness oriented recreation;*

(d) *water, fisheries, and **wildlife resource purposes**.* (Emphasis added.)

or other purposes permitted by the regulations to the Act or compatible with purposes (a) through (d). As well, Section 4(c) of the Ministry of Forests Act (RSBC Chapter 272, 1979) states that one of the main purposes and functions of the Ministry is to:

> *... plan the use of the forest and range resources of the Crown, so that the production of timber and forage, the harvesting of timber, the grazing of livestock, and **the realization of** fisheries, **wildlife**, water, outdoor recreation and other natural resource **values are coordinated and integrated**, in consultation and cooperation with other ministries and agencies of the Crown and with the private sector.* (Emphasis added.)

A great deal of information on deer and elk in coastal forests has been collected over the years by researchers from universities (e.g., Cowan 1945; Gates 1968; Janz 1983; Bunnell and Jones 1984) and government (e.g., Hebert 1979; McNay and Doyle 1987; Brunt *et al.* 1989; Nyberg *et al.* 1990a, 1990b). Seldom, though, has that knowledge been made available in a form easily used by managers. This handbook aims to change that by (1) summarizing and interpreting information on the relations between deer, elk, and timber on the south coast; and (2) presenting the results in a format and language designed to be as useful as possible for routine planning and management of those resources.

FOCUS OF THE HANDBOOK

The region for which this book was written encompasses all areas south of Cape Caution that are clearly under the influence of the coastal climate (Nuszdorfer *et al.* 1985) (see Figure 8, p. 9). This geographic limit imposes two biological restrictions: it ensures that only plant communities typical of the south coast are included, and it restricts, to a single sub-species of each, the number of deer and elk taxonomic categories that must be considered. The coastal focus reflects the experience of the authors and the results of the research from which many of the management interpretations have been drawn, especially the results of the Integrated Wildlife-Intensive Forestry Research (IWIFR) program (Bunnell 1985; Brunt 1987; Nyberg 1987).

There are three reasons for limiting the handbook to Columbian black-tailed deer and Roosevelt elk:

1. Most of the timber-wildlife conflicts on the coast have concerned the protection of deer and elk habitats from logging, especially on Vancouver Island but also on the adjacent mainland.
2. Roosevelt elk do not occur elsewhere in British Columbia (Figure 2), and Columbian black-tailed deer begin to intergrade gradually with the Sitka deer subspecies at the northern edge of the handbook area (Figure 3).
3. We know more about deer, elk, and their habitats than we do about any other wildlife species.

We do not know, however, all that we would like to, even about these two relatively well-studied animals. The information that follows will need to be updated continually as new studies and management experiences reveal new insights. Also, while many of the principles and relationships are common to other subspecies of deer and elk and to other forest types, the handbook is designed specifically for the forests of the southern coast. Anyone proposing to use it for other areas or other subspecies of deer or elk should do so only on the advice of experienced local foresters and biologists.

Figure 2. In Canada, Roosevelt elk occur only on Vancouver Island and at a few localities on British Columbia's southern mainland.

Figure 3. Columbian black-tailed deer are common throughout the area covered by the handbook.

HISTORICAL OVERVIEW

For many years, coastal logging was thought to improve deer and elk habitat by removing "barren" mature and old-growth forests, thus promoting increased forage production and larger deer populations (Cowan 1945). As harvesting expanded to new areas and forest regrowth progressed in older cutblocks, biologists realized that the benefits of increased forage would not last forever, for shrubs and herbs disappeared quickly once the canopies of regenerating stands closed in. The large openings produced by "progressive clearcutting" also demonstrated that no matter how much forage was available, much of it would remain unused by deer and elk if they could not find cover nearby.

Furthermore, biologists came to realize that recently logged areas made exceedingly poor habitats for both elk and deer during winters with deep, long-lasting snowpacks. This point was driven home by the severe winter of 1968-69, in which as many as 100 000 deer may have died of starvation and cold in the mountainous regions of Vancouver Island (Smith 1969). Widespread surveys during the early 1970's showed that deer concentrated most densely in old growth during severe winters, where they found reduced snow depths, moderate amounts of shrubs, and abundant litterfall of arboreal lichens which provided habitats far superior to those available in younger forests (Hebert 1979). Elk were also found to winter in old-growth forests in many areas of Vancouver Island, although they used immature forests extensively where preferred valley-bottom ranges had already been logged.

Biologists and foresters thus began seeking ways to reduce conflicts between logging and wildlife through better planning of forestry operations. Until 1970, however, there was no formal process for incorporating protection measures for wildlife habitat into timber management plans. In that year, the "referral system" for review of logging plans was extended to include wildlife biologists from the Ministry of Environment's (MOE) Fish and Wildlife Branch (Pearse 1976), and deer and elk habitat became a major issue in timber planning and management. Logging plans soon flooded the desks of the few biologists available, who did their best to consider the needs of deer and elk for forage, cover, and winter range. At their request, some old-growth timber was deferred from logging to provide winter range. Industrial foresters then were faced with new constraints on their operations, some of which affected profitability. Forest Service managers had to make hard decisions about trade-offs between timber and wildlife, but were provided no means for judging the public benefits at stake.

These factors led to many years of conflict among agencies and industry in the management of public forest land on the coast. And most of the problems remain today. The years since 1970 have seen attempts to replace the referral system with a more comprehensive approach to integrated resource planning (an approach initially called the "folio system," now "local resource use planning"), but referrals remain the main mechanism. Despite a detailed evaluation of timber harvest and deer and elk needs for winter habitat conducted for north-central Vancouver Island (B.C. Ministry of Environment and Ministry of Forests 1983), the ultimate fate of most old-growth stands that are deferred from logging in that and other areas remains in doubt (Figure 4). As well, the operations of forest companies continue to be constrained by measures to protect and enhance the value of deer and elk habitats.

The complexity of resource planning seems likely to increase even further as a result of a mid-1987 agreement between the B.C. Ministry of Forests and the Ministry of Environment.[1] It ensures wildlife managers of the opportunity to review silvicultural plans of the Forest Service and forest licensees.

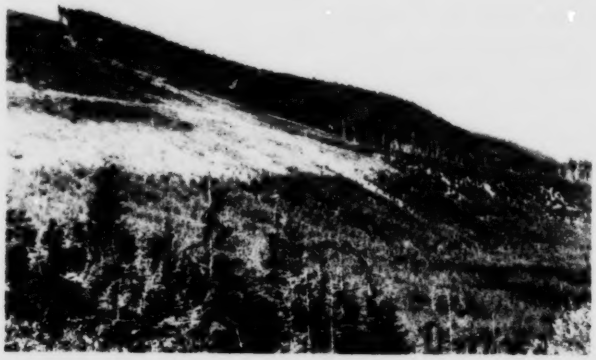

Figure 4. Many old-growth stands on Vancouver Island and the mainland are deferred from logging to provide critical winter ranges for deer.

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[1] Memorandum of Understanding Concerning Coordination of Silvicultural Activities and Fish and Wildlife Management Between Ministry of Forests and Lands, Ministry of Environment and Parks, and Department of Fisheries and Oceans. April 1987.

THE RESOURCES

Deer and Elk

Columbian black-tailed deer occur in British Columbia from the United States border to near Rivers Inlet. Roosevelt elk occur only on Vancouver Island and, in very small numbers, at two locations on the mainland. Within these areas, black-tailed deer are found everywhere but on the smallest islands; Roosevelt elk populations are often isolated or clumped.

Accurate census of ungulate populations in coastal forests is virtually impossible because cover is so dense. Recent estimates of deer and elk populations prepared for the regional wildlife and habitat plans of the Ministry of Environment indicate that black-tailed deer number approximately 140 500 (115 750 ± 20% in MOE Vancouver Island Region and 24 750 ± 20% in MOE Lower Mainland Region). Elk are estimated to number between 2170 and 2770.

Over the past 15 years, deer numbers on Vancouver Island have declined substantially because of wolf predation (Janz 1989) (Figure 5). Prior to the increase in wolf numbers in the mid-1970's, deer numbers on Vancouver Island were directly related to habitat carrying capacity resulting from logging development (Hebert 1979). Effects of the severe 1968-69 winter, for example, were most pronounced on southern Vancouver Island where, because of past logging history, vast areas were dominated by young, regenerating forests and few old-growth winter ranges remained. Weather and habitat conditions affect deer numbers similarly on the southern mainland coast.

Elk populations also declined significantly on southern Vancouver Island during the 1968-69 winter because of deep snow. Elk populations recovered gradually over the next decade in response to a series of mild winters, but increased illegal kills and unregulated native harvests have recently slowed the recovery.[2] The present status of elk on northern Vancouver Island is more encouraging. Most herds are stable or increasing because of the recent mild winters, a favourable habitat mosaic in many watersheds, and relatively low levels of illegal harvest. Wolf predation is, however, affecting some elk herds in watersheds where deer numbers are low and wolves are switching to elk as an alternative prey (Janz and Becker 1986). Effects of wolf predation on elk populations would likely increase during severe winters as elk concentrate on winter ranges and become less mobile and less healthy.

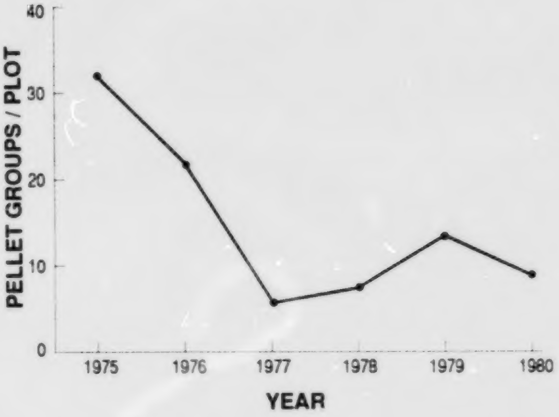

Figure 5. The 1975-80 trend in the deer population of an unlogged, unhunted watershed on northern Vancouver Island indicates the effects of wolf predation (from Jones and Mason 1983).

Recreational use of black-tailed deer and demand for Roosevelt elk are high. An average of 23 800 deer hunters generated 189 140 hunter-days of recreation on the south coast annually over the past decade, harvesting an average of 12 100 deer (approximately 40% of the provincial deer harvest). Demand for elk hunting opportunities is especially high; applications for limited entry hunts exceeded available authorizations by an average factor of 28:1 over the 1981-87 period. Elk hunting provided only 970 hunter-days per year on average, however, due to the tightly controlled harvest and high success rates.

Non-hunting activities associated with deer and elk are also very significant. In 1983, 48% of the non-hunting users of wildlife on Vancouver Island (44 065 people) and 39% on the Lower Mainland (93 190 people) participated in direct non-hunting activities (viewing, photography, nature study) related to deer and elk (Figure 6). Ungulates were second to marine mammals as the species group generating "most interest" among those surveyed (Reid *et al.* 1986).

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[2] B.C. Ministry of Environment. 1989. Regional wildlife plan for the Vancouver Island Region. Wildlife Branch, Victoria, B.C. In preparation.

Figure 6. The opportunity to see deer and elk attracts many people to the forest.

Economic value of resident deer and elk hunting on Vancouver Island and the Lower Mainland in 1986 is estimated to have been $5.2 million based on willingness-to-pay figures derived from Reid (1985). Actual expenditures exceeded $11 million. The economic value of various direct non-hunting wildlife activities by Lower Mainland and Vancouver Island residents exceeded $82 million. The proportion of this value attributable to deer and elk is not known, but likely approached $35 million in 1986.

The black-tailed deer population of the southwest coast of British Columbia is thus a valuable resource in both regional and provincial contexts. As the sole indigenous Canadian population, Roosevelt elk on Vancouver Island also represent a valuable and unique resource, not only provincially but also nationally. Deer and elk management objectives are based on the high public demands for these resources. Given the high value of forest lands in southwestern British Columbia for timber production and the importance of forest habitat in determining population capability, integrated resource planning and management are critical to meeting deer and elk objectives.

The Forests

Commercial forests cover little more than half of British Columbia's land base of 95 million ha, yet those forests account for 55% of Canada's commercial reserves. As a result, the timber industry is the most important in the province and one of the most important in the country. Almost all communities in British Columbia rely on timber to some degree to support their economies. Over half of the province's exports and about 46% of the value of shipments from all manufacturing in the province come from timber (Figure 7) (Council of Forest Industries of British Columbia 1986). More than 79 million m³ of timber were harvested in 1986 (B.C. Ministry of Forests and Lands 1987), and 78 000 people were employed directly in the forest industry.

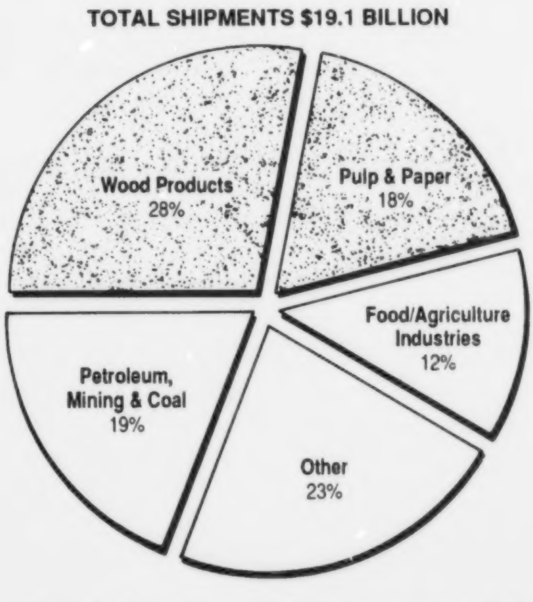

Figure 7. Manufacturing shipments by sector in British Columbia, 1985 (Council of Forest Industries of British Columbia 1986).

Coastal forests hold higher volumes and grow faster than those elsewhere in the province. The Vancouver Forest Region, composed of the area covered in this book plus the mid-coast and the Queen Charlotte Islands, produced almost one-third of the provincial harvest of timber in 1986, but only one-fifth of the area logged. The Vancouver Region contains 5.4 million ha of productive forest land, of which 3.7 million ha hold mature timber totalling 2.05 billion m³ in volume. The dominant species, western hemlock (*Tsuga heterophylla*), accounts for about one-third of the mature volume. Other important species are western redcedar (*Thuja plicata*), amabilis fir (*Abies amabilis*), and Douglas-fir (*Pseudotsuga menziesii*).

Coastal forests contribute to the well-being of the citizens of our province in other ways, too. Recreationists find beauty in the forests and take pleasure in camping, hiking, fishing, hunting, and many other pursuits (and they spend money in the process). Domestic water users and fish depend on the clean water and stabilized flows available in forested watersheds. Thousands of species of wild plants and animals live in complex forest ecosystems. Native people make the forest a focus of their culture and spirituality. And people within and far beyond British Columbia value the unlogged forest as a heritage of simpler times, when the hand of European man was not yet evident.

This region of abundant and valuable timber is also the province's most populated, and is its economic, financial, and cultural heart. Thus, people, resources, and resource uses are concentrated in a relatively small area. The result is often land use conflict. On Vancouver Island, in particular, the interactions between timber production and wildlife uses have been some of British Columbia's most intensive.

MANAGEMENT

Deer and Elk

Management of the provincial wildlife resource is the responsibility of the Wildlife Branch, Ministry of Environment. The mission of the wildlife program is "to manage the Province's wildlife resources for the benefit and enjoyment of British Columbians, by maintaining an optimal balance between ecological, cultural, economic, and recreational needs."[3] A major goal is to maintain and enhance wildlife and their habitats to ensure an abundant, diverse, and self-sustaining wildlife resource throughout British Columbia. The general goals of the MOE deer and elk management programs are to maintain, enhance, and promote opportunities to view and hunt these species in their natural habitats.

Present management objectives for deer in MOE Region 1 (Vancouver Island) are to increase deer numbers to approximately 178000 by 1996, resulting in 12000 deer harvested and 172000 days of recreation annually. These targets are similar to levels that occurred during the late 1970's and early 1980's. Priorities for deer management activities on Vancouver Island reflect habitat capability, land tenure, and various factors influencing public demand, including deer numbers, access, travel costs, aesthetics, and tradition (Figure 8). About two-thirds of the high-priority zone is made up of private forest land, limiting the opportunity for MOE input to habitat management. The Roosevelt elk objective for Vancouver Island is to increase elk numbers to approximately 3000-3800 by 1996, which should generate 2350-3200 hunter-days of recreation and provide increased viewing opportunities.

Management objectives for deer in the MOE's Region 2 (Lower Mainland) are to maintain current population levels and distribution to provide viewing and hunting opportunities. By the end of the next decade, hunting demand is expected to approach 9000 hunters per year, harvesting 3300 deer in 80000 hunter-days of effort. Priorities for management activities, based on access and deer productivity, are high in management unit (M.U.) 2-2, 2-3, 2-5, and 2-11 (Figure 8). The Roosevelt elk management objective over the next decade in the Lower Mainland Region is to establish viable populations in at least two locations.

The major activities required to achieve deer management objectives are wolf control and maintenance of critical winter habitat. If wolf densities are held at or below one per 150 km^2 in the high-priority zone for ungulate production, depleted deer herds should recover, established herds should not decline, and wolves should persist in low numbers (Janz and Hatter 1986). Over the longer term, maintenance of deer numbers will depend on present and future habitat management activities. The most important are maintenance of old-growth winter ranges, provision of habitat diversity with emphasis on forage production, and manipulation of young growth for both forage and cover, including creation of critical winter ranges in young forests.

The effects of hunting on deer populations are minor compared to the effects of habitat quality and wolf predation. For example, before the increase in wolves in the Nimpkish Valley, hunting seasons were liberal because habitat conditions were favourable and deer were abundant. There was no evidence of a deer decline due to hunting, even with a high proportion of antlerless deer in the harvest (>25%). After populations fell during the severe winters of 1968-69 and 1971-72, deer numbers increased rapidly under the same liberal hunting seasons. Hunting mortality, however, can be additive to natural mortality when populations are depressed below the carrying capacity of the habitat. Therefore, in an attempt to aid deer recovery from wolf predation, hunting seasons have recently been restricted by the elimination of antlerless seasons and the reduction of bag limits.

The effects of hunting are of greater management concern for elk than for deer because of the social behaviour, low dispersal rates, and lower productivity of elk compared to deer. Thus, future harvests will continue to be controlled by limited entry hunts. Management activities required to meet population objectives include the curtailment of illegal and unregulated harvest, especially on southern Vancouver Island, by increased enforcement and cooperative management with treaty Indians. Habitat management for elk will focus on protection of important old-growth winter ranges and special habitats such as wetlands and vegetated slides,

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[3] B.C. Ministry of Environment. 1989. Provincial wildlife strategy. Wildlife Branch, Victoria, B.C. In preparation.

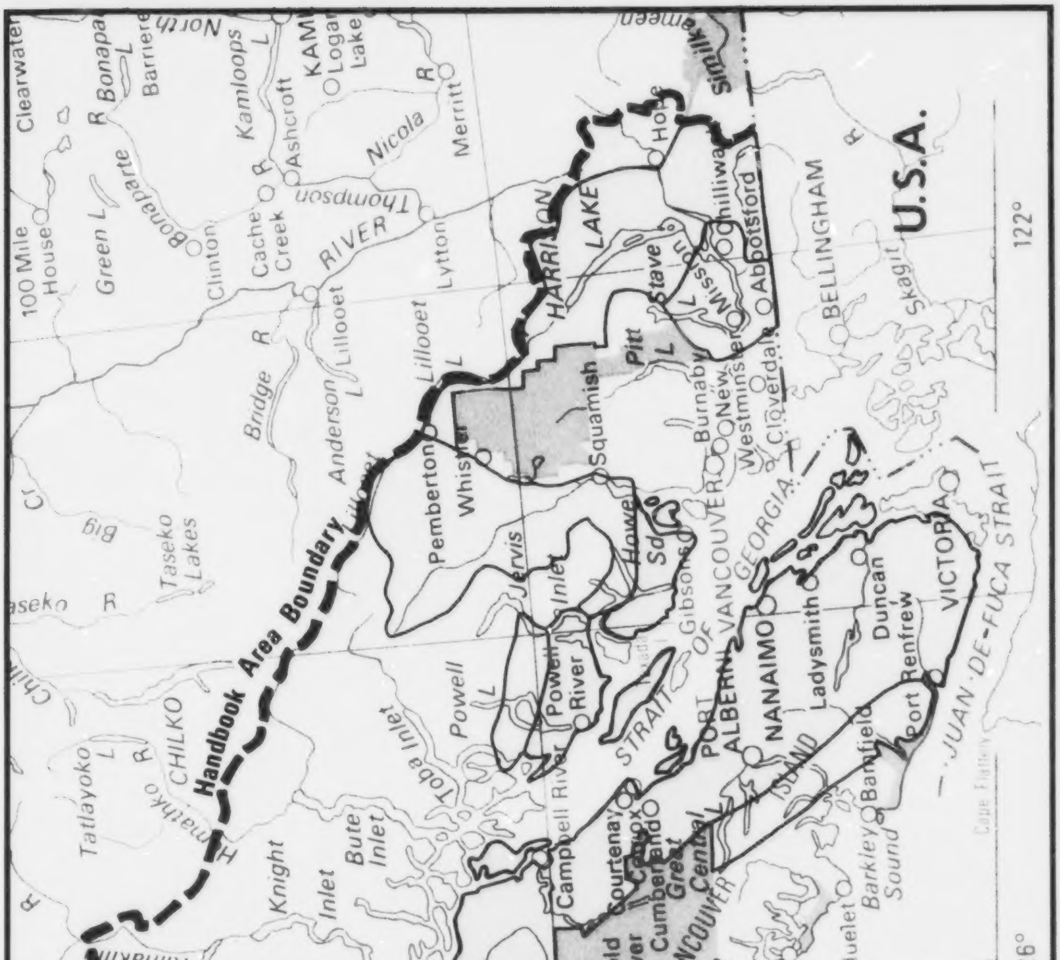
DEER MANAGEMENT PRIORITIES
WITHIN HANDBOOK AREA
Handbook Area Boundary
International Boundary
Parks
Deer Management Priorities:
High
Moderate
Low
20 0 20 40 60 80 100 km
Handbook Area Boundary
U.S.A.
126°
122°
Port Hardy
Port McNeill
Port Alice
Alert Bay
Nimpkish L
Kelsey Bay
Sayward
Zeballos
Tahsis
Gold River
Campbell River
Courtenay
Comox
Cumberland
Powell River
Pemberton
Whistler
Squamish
Gibsons
VANCOUVER
Burnaby
New Westminster
Cloverdale
Abbotsford
Chilliwack
Mission
Hope
HARRISON LAKE
Pitt L
Stave L
PORT ALBERNI
NANAIMO
Ladysmith
Duncan
VICTORIA
Port Renfrew
Bamfield
Ucluelet
Tofino
Kyuquot
STRAIT OF GEORGIA
JUAN DE FUCA STRAIT
VANCOUVER ISLAND
Great Central L
BELLINGHAM
Lillooet
Lytton
Merritt
Kamloops
Clinton
Cache Creek
Ashcroft
100 Mile House
Thompson
Nicola
Similkameen
Queens Sd
Smith Sound
Quatsino Sound
Kyuquot Sound
Nootka Sound
Barkley Sound
Allison Harbour
Knight Inlet
Bute Inlet
Toba Inlet
Jervis Inlet
Howe Sd
Powell L
Owikeno L
Tatlayoko L
CHILKO
Taseko Lakes

Figure 8. Deer management priorities on the south coast as set by the Ministry of Environment.

provision of forage and cover in regenerating forests, and manipulation of young stands to provide snow interception cover.

Numerous opportunities exist to increase distribution and abundance of elk by transplants. This will be a major focus of elk management over the next 5-10 years. Transplant operations on Vancouver Island and the Sechelt Peninsula are currently being used to re-introduce elk to areas that historically supported substantial populations (Figure 9). Before elk are transplanted into an area, all involved landowners and forest tenure holders are consulted and agreement is sought on any alterations felt to be necessary in planned habitat management prescriptions.

Figure 9. Elk have been transplanted to several areas on Vancouver Island and to the Sechelt Peninsula in recent years.

The planned long-term increase in Roosevelt elk and black-tailed deer depends on availability of good-quality habitat because the carrying capacity of habitat sets the limit on population size and productivity. Ultimately, managers would like to be able to relate numbers of animals to habitat quality. The best estimates of population size or density for coastal British Columbia come from aerial surveys of elk herds and pellet-group surveys (an indirect estimation technique) of deer. These data indicate that deer, for example, often exceed 10 per square kilometre in areas of good habitat in partially logged watersheds and may reach concentrations of more than 90 per square kilometre on critical winter ranges. Although such estimates can be used to develop general guidelines for the amount of habitat required to support a given population, they are not accurate enough to relate directly to the amounts of specific types of habitat required to produce a desired number of animals. Given the complex and dynamic interactions among vegetation, predators (including man), weather, and deer and elk, the management of forest habitats to meet animal production objectives will continue to be as much an art as a science.

Habitat quality changes much more slowly than do mortality factors such as predation, overharvest, severe winters, and disease, which are of relatively short duration or can be controlled through wildlife management activities. Once it is degraded, habitat quality requires many years to recover. For these reasons, this handbook concentrates on the habitat relations of elk and deer, and on techniques for managing habitat.

The Forests

The Ministry of Forests Act (RSBC Chapter 272, 1979), the Forest Act (RSBC Chapter 140, 1979), and the Range Act (RSBC Chapter 355, 1979) give the Forest Service prime responsibility for administering Crown forest, range, and recreation resources. Specifically, the Ministry of Forests Act requires the Forest Service to:

1. encourage productivity of the resources;
2. manage them for the economic and social benefits of the province;
3. plan the use of forest and range resources in an integrated manner, in consultation with other agencies and the private sector;
4. encourage a competitive timber processing industry; and
5. assert the financial interests of the Crown.

To accomplish these objectives, the Forest Service enters into numerous agreements with the private sector and other government agencies. On Crown lands, it issues tenures that share authority for resource management with the forest industry. The tenure types used to regulate timber harvesting include: 1) Tree Farm Licences (TFL's); 2) Forest Licences; 3) Timber Sale Licences; 4) Woodlot Licences; and 5) other minor tenures. The TFL and Woodlot Licence are termed "area-based" tenures because they provide continuing harvesting rights within a prescribed licence area assigned to the tenure holder. In contrast, a Forest Licence is a "volume-based" tenure which provides the licensee a right to harvest a set volume of timber from somewhere within a Timber Supply Area (TSA) shared by other tenure holders.

Regardless of the tenure, harvesting is carried out according to an approved plan under which the licensee fulfills certain obligations. The Forest Service's planning system encompasses a family of plans, from provincial strategies to detailed cutting plans (Figure 10). Overall policy and procedures

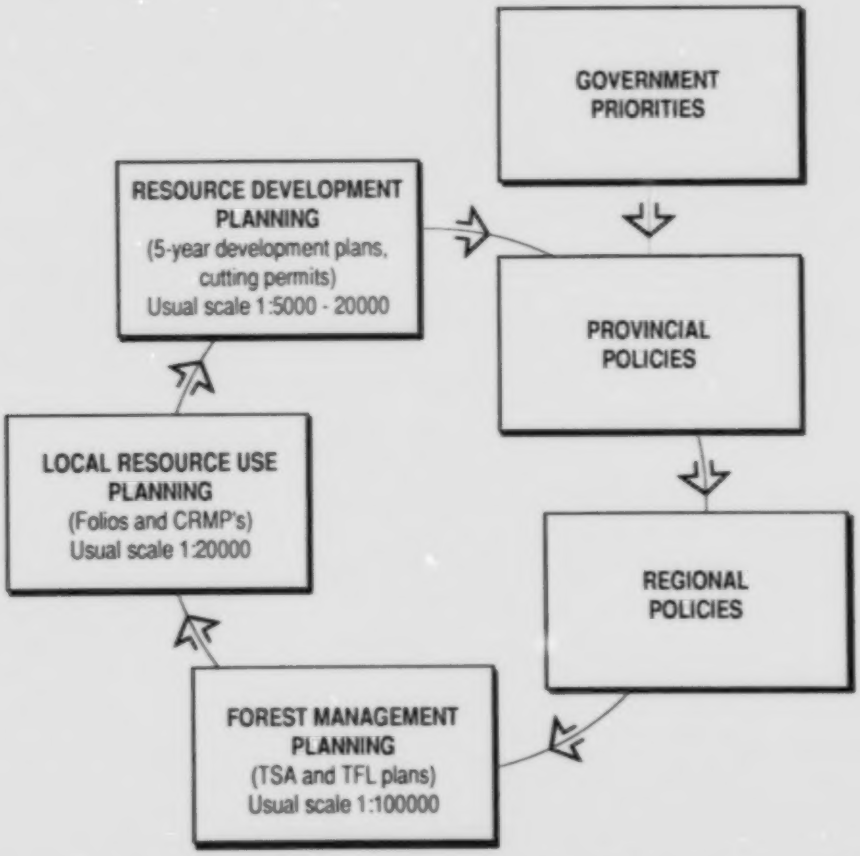
GOVERNMENT PRIORITIES
PROVINCIAL POLICIES
REGIONAL POLICIES
FOREST MANAGEMENT PLANNING
(TSA and TFL plans)
Usual scale 1:100000
LOCAL RESOURCE USE PLANNING
(Folios and CRMP's)
Usual scale 1:20000
RESOURCE DEVELOPMENT PLANNING
(5-year development plans, cutting permits)
Usual scale 1:5000 - 20000

Figure 10. Planning levels in the Forest Service hierarchy (CRMP = Co-ordinated Resource Management Plan).

are developed at headquarters in Victoria. Timber Supply Area and TFL plans then outline the major considerations for resource use and establish an approved rate of harvest for management areas in concert with provincial policies. Both types of plans serve similar purposes, but TSA plans are developed by the Forest Service, while TFL plans are prepared by forest companies.

To establish a rate of harvest (allowable annual cut or AAC), the Forest Service considers the long-term needs of the forest industry, the available timber supplies, and the needs of other resource users. Other government agencies, the forest industry, and the public are involved when these plans are prepared. The plans assess the impacts of harvesting, silviculture, and protection programs on long-term timber supplies and on other uses.

Under the umbrella of the TSA or TFL plan, more specific plans are prepared. These include:

1. local resource use plans, which contain prescriptions or suggestions for integrating resource management in critical areas;
2. 5-year development plans, prepared by the tenure holder for the areas he will be operating in over the next 5 years; and
3. operational plans, which are detailed cutting plans.

Wildlife issues are considered in all these plans. Local resource use plans are prepared only occasionally (usually when timber development begins in a previously unlogged watershed), but offer the best opportunity for comprehensive planning of integrated management of timber and wildlife. Through the referral of 5-year development plans to the Ministry of Environment, wildlife concerns are addressed cutblock by cutblock as timber development proceeds in all forms of tenure. The referral system forms the major mechanism for integrating timber and wildlife management. Reviews of operational plans in the field allow important issues specific to certain sites to be discussed in detail (cutblock boundaries, for example).

Recent developments in forestry planning promise to complement the new techniques and streamlined planning procedures described in this book. As a recently added member of the steering committees for TSA plans, the Ministry of Environment has become more effective in identifying important areas of deer and elk habitat, and is now a partner to discussions of the acceptable level of harvest in TSA's. This should ensure more thorough consideration of the objectives for both timber and wildlife on Crown land. It should also better define the true extent of the harvestable land base, and encourage objective assessments of trade-offs between timber production and habitat preservation. At the operational planning level, assessment of regeneration techniques suitable for each site (the pre-harvest silvicultural prescription) is now required before harvesting proceeds. Through these site visits, the soil and understory conditions that determine future forage potential can be identified.

CONFLICTS AND OPPORTUNITIES

Deer and elk in the Pacific Northwest have long inhabited and adapted to an environment dominated by old-growth coniferous forests. Except for large and infrequent fires, the habitats supporting wildlife populations were relatively stable before the arrival of the white man (Figure 11). With human settlement and the start of extensive logging in the late 1800's, habitat change became much more rapid. Forest and wildlife resources were exploited with little need for management of the seemingly endless supply of each. By the late 1960's, limits to the abundance of forest resources were apparent, as were public concerns about the lack of integrated management. The need to ensure long-term supplies of timber resulted in an intensification of forestry practices after 1975, producing further modifications to habitat structure. The forests and wildlife habitats of the future are now being shaped by early stocking of logged areas, control of competing vegetation, protection of young seedlings from damage, and stand tending activities designed to produce valuable timber within 60- to 80-year old rotations (Figure 12).

The liquidation of old-growth forests and intensive management of young forests truncate natural succession, drastically restricting both the period of abundant forage production in early seral stages and the availability of the oldest seral stages. Deer and elk populations now must adapt not only to widespread changes in habitat structure due to logging development, but also to the more subtle effects of silviculture treatments on regenerating forests. The present distribution of deer and elk throughout most of their past range bears testimony to the adaptability of these species. However, the density or number of animals required to meet the public demand and support viable predator populations is often higher than would be produced by forest management designed for timber production alone. Conflict between those who value coastal forests mainly for their timber potential and those who favour wildlife will likely always be present, but numerous opportunities exist to reduce the degree of conflict and develop solutions to meet the challenges of integrated management.

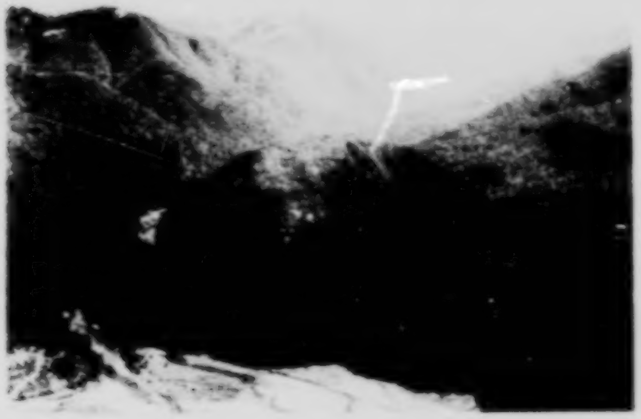

Figure 11. Most coastal areas were covered in old-growth forests before widespread logging began.

Figure 12. Most areas have now been at least partially logged.

Because logging and forestry activities have by far the greatest influence on wildlife habitat in coastal forests, the adage that "timber management is wildlife management" (Thomas 1979, p. 13) is appropriate to southwestern British Columbia. The amount, composition, and arrangement of food and cover which form the life requisites of deer and elk are dictated by the location, timing, and extent of timber management activities. Forest managers thus control the features of stands that determine habitat values. By understanding the effects of forestry practices, specific activities can be planned to produce the desired habitat quality over time and space. Application of these management regimes, in conjunction with long-term planning systems, will encourage thoughtful planning for joint management of deer, elk, and timber.

SPATIAL AND TEMPORAL THEMES

Throughout this handbook, four themes or systems are used to organize information. First, the area to which the handbook applies is stratified geographically by "snowpack zones," which are based on snow depth and duration. Second, the habitat needs of deer and elk are divided into three types of seasonal habitats, reflecting the annual cycle of animal activity and habitat use. Third, the details of site influences on forage and cover resources are generalized according to "understory types" and "special habitats" that reflect climate, soils, and plant communities. And fourth, changes in structure and composition of plant communities over time are recognized in a scheme of five successional stages. Each of these themes is discussed more fully on the following pages.

Snowpack Zones

During winter, deer and elk face stresses far more severe than those encountered during other seasons. Not only are temperatures low and rains common, but both the quantity and quality of forage reach their lowest ebb. Furthermore, most females are growing fetuses, males are suffering aftereffects of the frenetic activity of the rut, and predation, disease, and accidents remain ever-present risks. The stresses of winter become even more severe whenever more than about 25 cm of snow accumulates on the ground. At such depths, many forage plants become covered by a blanket of snow, and animal movement is impeded. This simultaneous reduction in energy intake and increase in energy output is sometimes enough to kill animals through malnutrition, especially when snow builds to great depths and lasts through much of the winter.

Consequently, depth and duration of the snowpack are critical factors influencing the capability of habitat to support deer and elk. Snowfall frequencies also help to determine habitat management priorities for various areas, such as the relative emphasis placed on summer forage versus winter cover from snow. The depth and duration of snow cover are therefore repeatedly emphasized as key management concerns in subsequent chapters, through the use of "snowpack zones" to stratify the handbook area. Four snowpack zones (Table 1) have been derived which recognize the influence of topography (especially elevation) and climate on snow and on the ability of forests to provide suitable winter habitat for elk and deer (Figure 13). A combination of climate station data,[4] biogeoclimatic units (Nuszdorfer *et al.* 1985), and local knowledge was employed in delineating the zones as shown in Figure 14.[5]

Ideally, these zones would be defined and mapped using simple numerical criteria such as average annual snowfall or the frequency of winters having snowpacks of given depths and durations. Unfortunately, weather and snow course stations on the coast are scattered widely and are located, for the most part, at the lowest and highest elevations, leaving a large gap in the middle where few data are available to assist in mapping zone boundaries. That gap happens to occur in the elevation range where forest management decisions have the greatest influence on deer and elk habitat — i.e., the moderate and deep snowpack zones.

Table 1. Characteristics of snowpack zones on the south coast

Snowpack zone	Approximate elevation range[a]	Snowpack	Winter cover suitable for deer and elk
Shallow	Sea level - 300 m	Usually shallow (<30 cm) and ephemeral. Critical snowpacks[b] occur less than once in 15 years.	Young stands can provide usable winter cover, given appropriate height, density, and canopy closure.
Moderate	200 - 600 m	Usually shallow (30-60 cm) but persistent for up to 2 weeks. Critical snowpacks occur every 5-15 years on average.	Both old growth and some younger managed forests can provide critical winter habitat.
Deep	500 - 900 m	Often deep (>60 cm) and persistent for 2 weeks or more. Critical snowpacks occur every 3-10 years on average.	Critical winter habitat is typically provided only by certain old-growth forests.
Very deep	>800 m	Usually more than 60 cm deep and persistent for most of the winter.	No provision for winter habitat is made through either habitat protection or enhancement.

[a] Elevations of the upper and lower boundaries of zones depend on local climate and topography (especially aspect). For example, the boundary between the shallow and moderate snowpack zones will generally occur further inland on the west (windward) coast than on the east coast of Vancouver Island, and at higher elevations on south than on north aspects.

[b] A critical snowpack for deer and elk is one persisting at 45 cm deep for 30 days or more.

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[4] Stordeur, L.A. 1981. Snow and black-tailed deer habitat on Vancouver Island. B.C. Min. For., Vancouver, B.C. Unpublished report.

[5] 1:600 000 scale copies of the snowpack zone map are available from Research Branch, B.C. Min. For., 31 Bastion Square, Victoria, B.C. V8W 3E7.

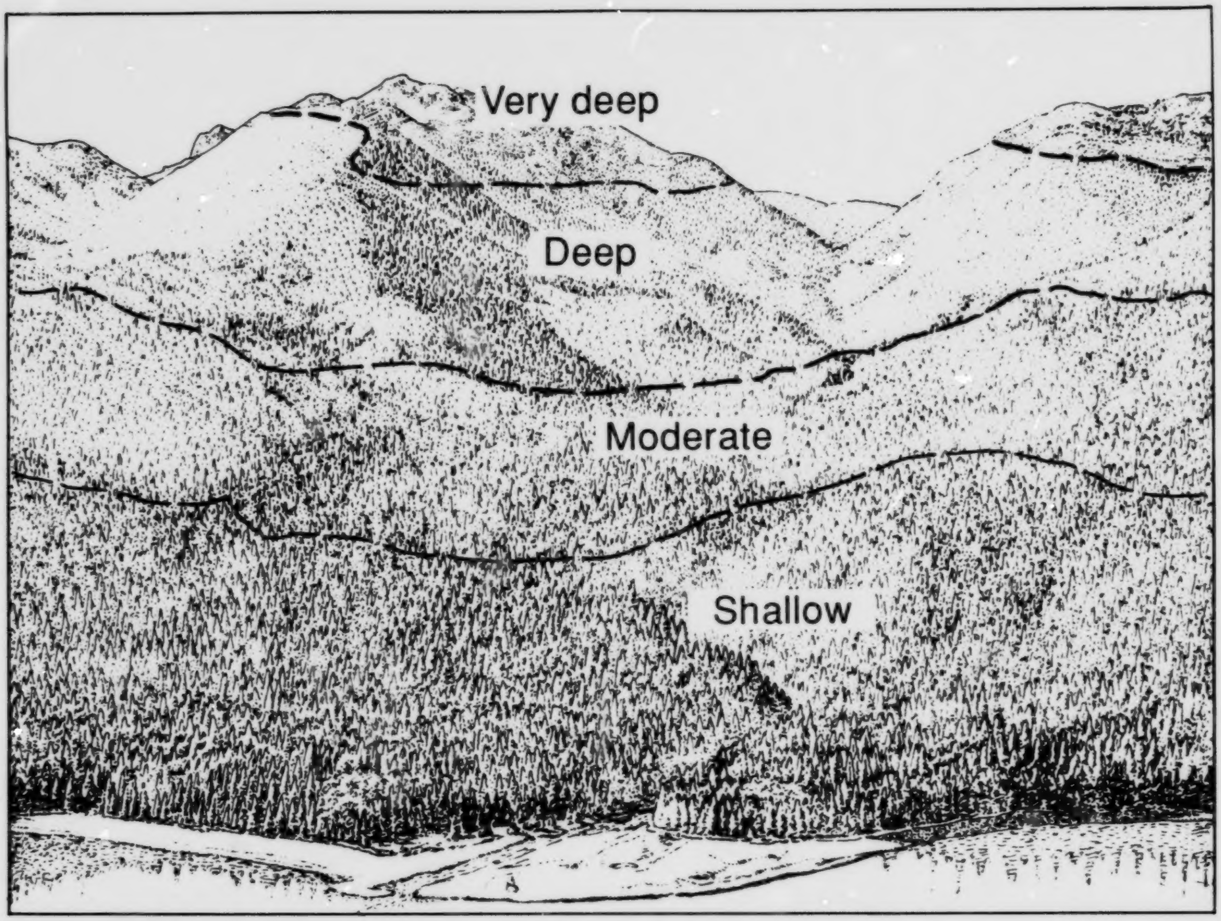


Figure 13. Generalized distribution of snowpack zones.

The great variability of coastal weather further complicates the mapping of zones. The concept of an average snowpack is of little use, because every year seems to bring a different amount of snowfall and a different sequence of snow accumulation and melt. Many winters on Vancouver Island and the coastal fringe of the mainland are largely snow-free at lower elevations, but periodic severe winters emphasize the danger of assuming that several years of mild winters indicate the trend for the future. It is the infrequent severe winters, such as those of 1968-69 and 1971-72, that force elk and deer populations down to low levels in the moderate and deep zones and restrict surviving animals to high-quality winter ranges.

The most useful definition for the snowpack zones, therefore, would be one based on the "return period" of winters of a given severity, such as those with a snowpack depth of 45 cm or more lasting 4 weeks. With sufficient data to define long-term trends and geographical extent of snowpacks, zones could be related directly to deer and elk survival and to management potentials (Nyberg *et al.* 1986). As discussed above, however, those data do not exist.

Nevertheless, stratification of the area is so important to habitat management that for this handbook estimated boundaries for snowpack zones have been drawn up from the best information available. Note, however, that the moderate and

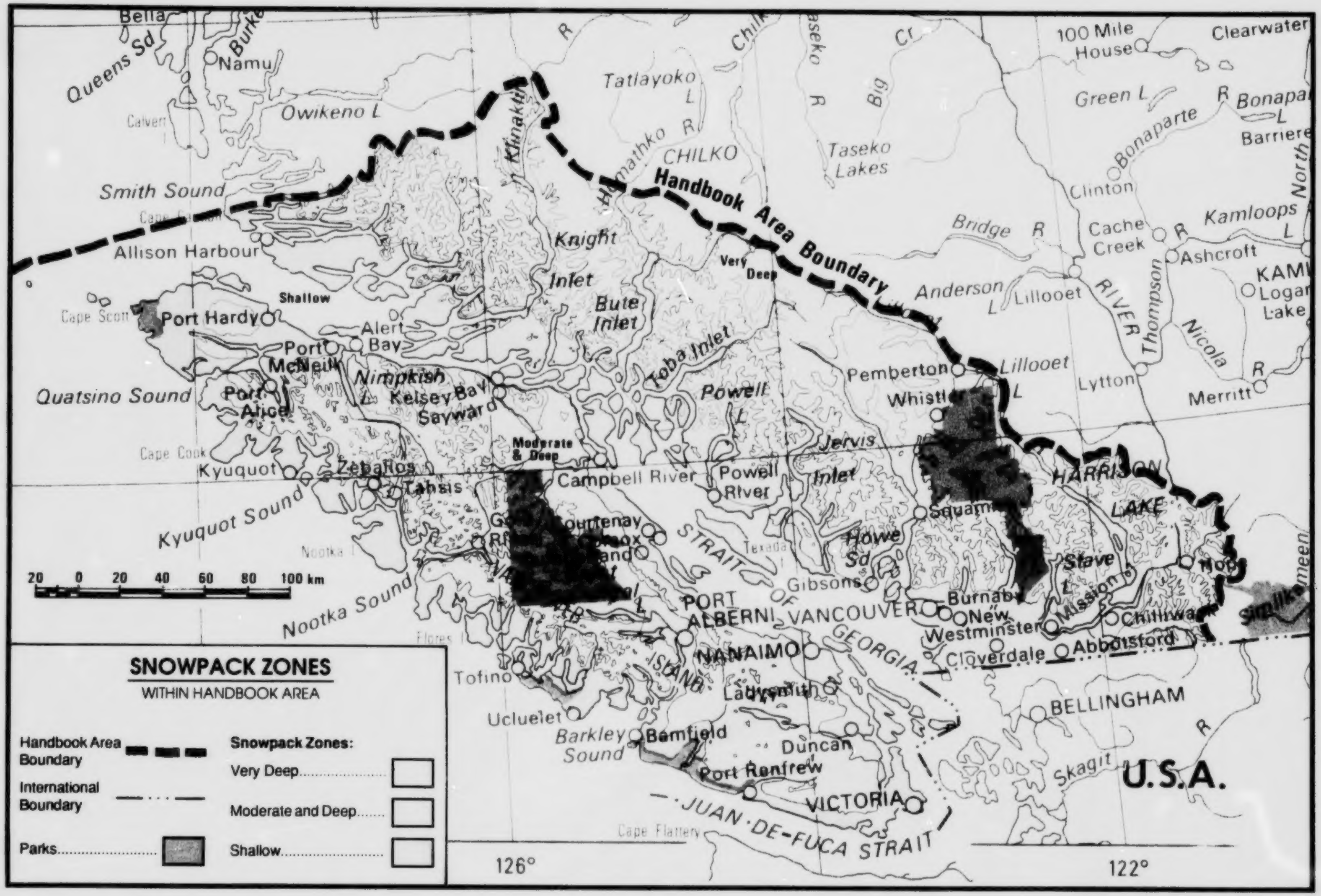

SNOWPACK ZONES
WITHIN HANDBOOK AREA
Handbook Area Boundary
International Boundary
Parks
Snowpack Zones:
Very Deep
Moderate and Deep
Shallow
20 0 20 40 60 80 100 km
Handbook Area Boundary
Very Deep
Moderate & Deep
Shallow
126°
122°
U.S.A.
Bella
Queens Sd
Namu
Burke
Calvert I
Owikeno L
Smith Sound
Cape Caution
Allison Harbour
Cape Scott
Port Hardy
Port McNeill
Alert Bay
Port Alice
Quatsino Sound
Nimpkish L
Kelsey Bay
Sayward
Cape Cook
Kyuquot
Kyuquot Sound
Zeballos
Tahsis
Nootka I
Nootka Sound
Flores I
Tofino
Ucluelet
Barkley Sound
Bamfield
Port Renfrew
JUAN·DE-FUCA STRAIT
Cape Flattery
VICTORIA
Duncan
Ladysmith
NANAIMO
PORT ALBERNI
VANCOUVER ISLAND
Campbell River
Courtenay
Comox
Denman Island
Gold River
STRAIT OF GEORGIA
Texada I
Powell River
Powell L
Toba Inlet
Bute Inlet
Knight Inlet
Klinaklini
Homathko R
Tatlayoko L
CHILKO
Chilko
Taseko R
Taseko Lakes
Big Cr
Jervis Inlet
Howe Sd
Gibsons
Squamish
Whistler
Pemberton
Lillooet L
Anderson L
Lillooet
Bridge R
VANCOUVER
Burnaby
New Westminster
Cloverdale
Abbotsford
Mission
Chilliwack
Hope
Stave L
HARRISON LAKE
Similkameen
BELLINGHAM
Skagit R
Lytton
Merritt
Nicola
Thompson
RIVER
Ashcroft
Cache Creek
Clinton
Bonaparte
Green L
100 Mile House
Clearwater
Bonaparte L
Barriere
Kamloops L
North
KAMLOOPS
Logan Lake

Figure 14. Snowpack zones in the handbook area. For details see the 1:600 000 scale map available from the Research Branch, B.C. Ministry of Forests, Victoria.

deep zones are not distinguished from each other. Knowledge of snow distribution is so scanty that it is not currently possible to draw the boundary between these two zones at this scale. Local knowledge of storm tracks, topographic effects on wind and temperature, and historical snow accumulations may allow the boundary to be mapped in certain areas, and we encourage discussion between timber and wildlife managers to identify such areas. Discussions should recognize the recent series of mild winters experienced in most areas of the south coast, however, and the possibility that one or more severe winters may be due in the near future. The implications of the snowpack zones to elk and deer ecology and to habitat management are discussed in subsequent chapters. Within each zone, the changing seasons impose different ecological needs and management concerns, as discussed in the next section.

Seasonal Ranges

Elk and deer change many aspects of their behaviour in response to seasonal variations in plant growth and weather conditions. Managers of habitat, if they hope to sustain healthy populations, must therefore recognize the varying needs of animals through the year. Throughout this handbook, ecological needs and habitat management implications are presented for each of three seasons: spring, summer through early fall (called "summer"), and late fall through winter (called "winter").

These seasonal categories recognize three generalized periods in a continuum of organism growth and weather. For our purposes, the spring season is defined as the time from the onset of growth of forage plants at lower elevations (usually March or April) through to the recession of snowpack and start of plant growth at all but the highest elevations (usually May). It is almost always much shorter than spring as defined by the calendar. This is a time of high energy demand as animals begin to recover condition after the stresses of winter, especially for pregnant females who are in the last trimester of pregnancy. It is also a time of moderating weather conditions, when temperatures are rising but still liable to drop dramatically as storms pass through. Forage plants burst into new growth, but forage abundance is still far below peak levels of late summer. During spring, migratory animals begin to move off their winter ranges as they search out high-quality forage.

The summer is the longest seasonal period, incorporating all of the calendar's summer months and part of its spring and fall, as well. The summer season begins when elk and deer are no longer restricted to lower elevations by snow or low-quality forage (usually May), and lasts until the first snows of winter drive migratory animals down from high elevations (often in late November). Deer and elk, especially lactating females, need large amounts of nutritious forage to sustain body growth and to lay on reserves of fat to carry them through the coming winter. Forage abundance reaches its peak and quality remains high until maturation of the year's new growth leads to reduced moisture content and digestibility (Figure 15). The weather is usually benign, although animals may need shade for relief from heat on some days.

The winter season begins with the first persistent snowfalls at upper elevations and lasts until warm days bring the first flush of new plant growth at the lowest elevations (November through March or April). It is a time of hardship for deer and elk, even in relatively mild years, because the quantity and quality of forage falls drastically as plants enter dormancy. Cold temperatures and strong winds sap the animals' stored energy, and the barrier to food and movement imposed by snow adds further to their burden of energy maintenance (Figure 16). Movements are usually restricted to a small portion of the annual range, often at elevations far lower than those occupied during summer.

Although the habitat needs of deer and elk are most critical during winter, the animals require suitable range year-round to prosper. For example, no matter how good the winter range, animals that cannot fatten themselves on abundant, high-quality food during spring and summer have little hope of reproducing and surviving the next year. On the other hand, the fattest of deer and elk cannot endure a whole winter of deep snowpacks and minimal forage intake. The emphasis on individual seasons in this book should therefore not obscure the importance of habitat in providing year-round range of high capability. Regardless of whether they are resident deer occupying an area of 200 ha for the whole year, or migratory elk moving 40 km between summer and winter ranges, animals must have access to habitat providing resources needed during all three seasons. The manager's greatest challenge is to provide appropriate amounts and proportions of these seasonal habitats while simultaneously achieving the set of objectives for timber production and other resource uses.

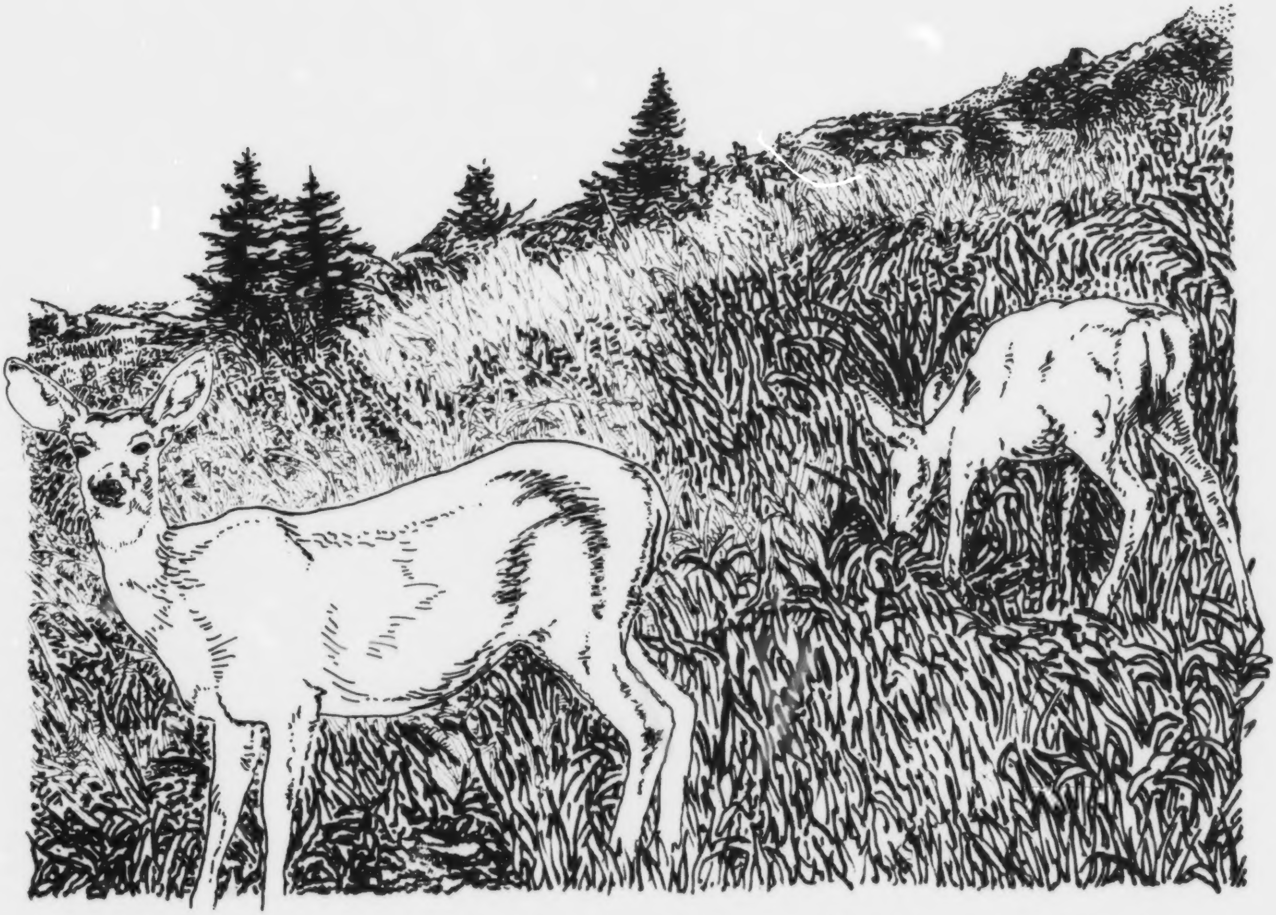
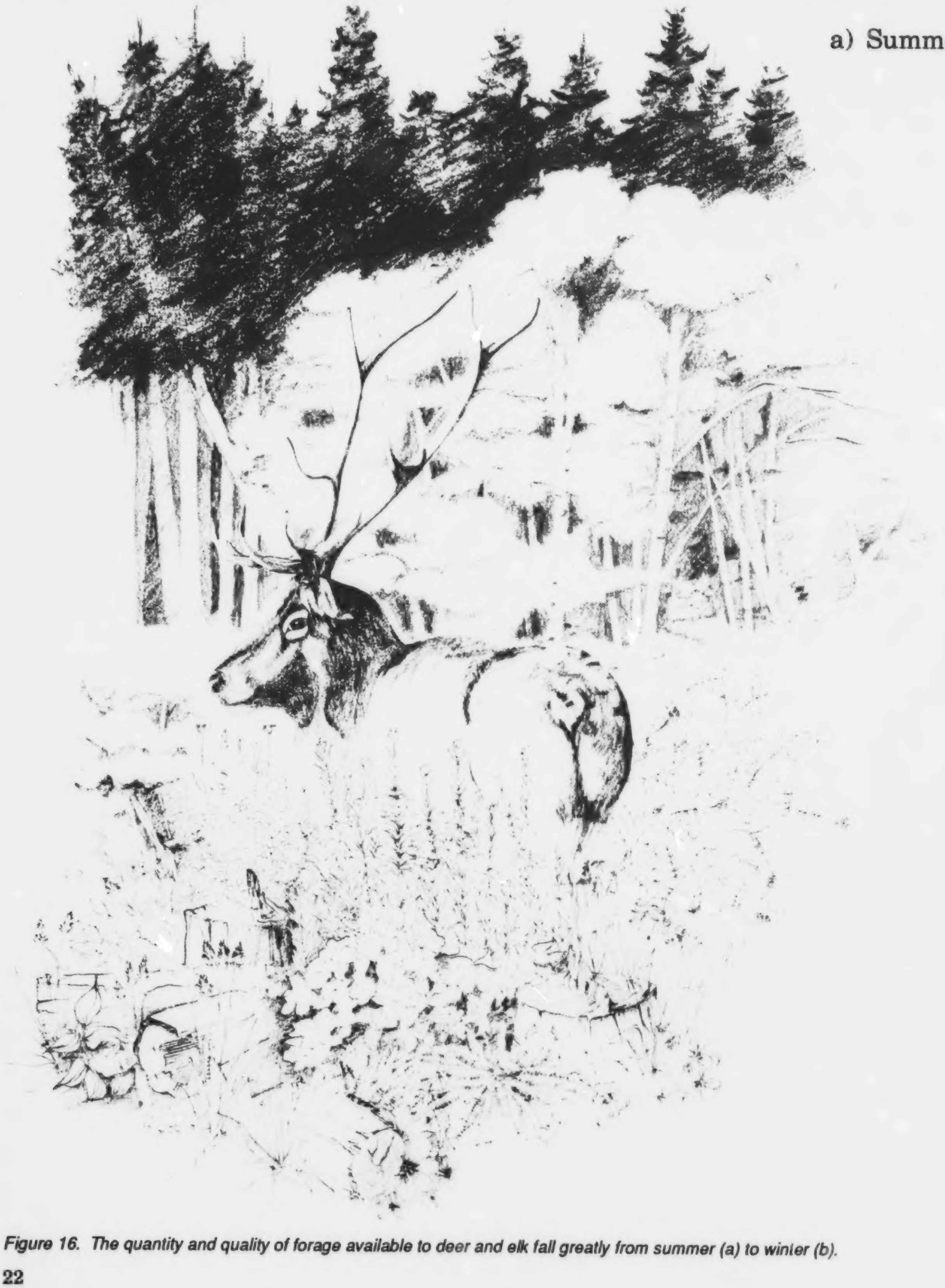


Figure 15. Delayed phenology at high elevations makes high-quality forage available throughout most of the summer.



a) Summer

Figure 16. The quantity and quality of forage available to deer and elk fall greatly from summer (a) to winter (b).

b) Winter

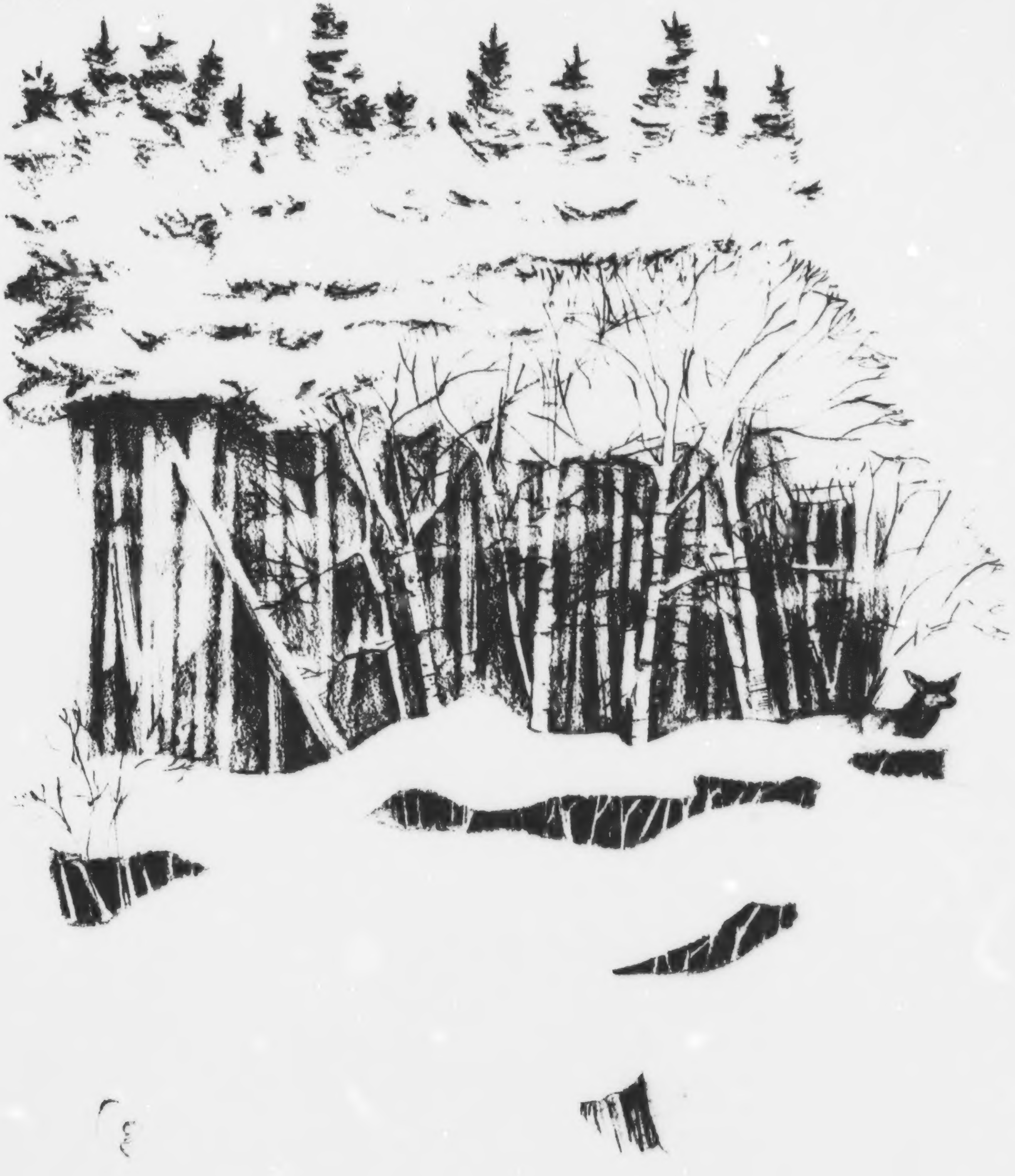


Figure 16. (Continued).

Understory Types and Special Habitats

To simplify application of the Forest Service's biogeoclimatic ecosystem classification (BEC) (Pojar *et al.* 1987) to deer and elk habitat, "understory types" (Table 2) have been derived from the "site units" of the BEC system. The types were derived from consultation with ecologists in the BEC program and IWIFR biologists familiar with deer and elk habitat relations. Understory types are interpretive units for forage and cover management, much as treatment units are interpretive units for timber management (Klinka *et al.* 1980). Most understory types are composed of groups of site units (Pojar *et al.* 1987) that provide similar forage resources, regardless of differences in soils and tree cover, but some types consist of only one site unit.

"Special habitats" (Table 3) are, with one exception, non-forested communities of high value to deer or elk, differentiated by topographic and vegetative characteristics. Timber management activities seldom occur on these sites. The exception, riparian habitat, consists of vegetation influenced by perennial or intermittent water, or both, on sites that are transitional between wetlands and upland terrestrial habitats (Brown 1985). Riparian habitats often occur on rich sites that are intensively managed for timber and are of special value to elk.

Detailed information about each understory type and special habitat is provided in Appendix 1 and Appendix 2. To aid planners and silviculturists, typical stand and site characteristics, plus a list of common or diagnostic understory species, are listed for each understory type. Understory species are omitted for special habitats because more obvious features distinguish these units. Ratings of potential forage values, by season, are given for each type and habitat, as are short descriptions of overall habitat value. Effects of forestry practices on forage production are described for several understory types for which local data are available. The relationships of understory types to biogeoclimatic units, soil moisture (hygrotopes), and soil nutrients (trophotopes) are shown in Figure 17. The combined effect of these three key factors strongly influences the vegetation present on a site, and these are the key items of knowledge used routinely by foresters during site diagnosis (Klinka *et al.* 1984) to evaluate site quality. Further information on the identification of understory types can be found in Appendix 1.

Table 2. Understory types of Vancouver Island and the coastal mainland of southern British Columbia

Understory type	Code
Black huckleberry - White-flowered rhododendron	BH-WfR
California brome	CB
Deer fern	DF
Huckleberry - Dull Oregon-grape	H-DOg
Huckleberry - Moss	H-M
Huckleberry - Rosy twistedstalk	H-RT
Indian hellebore	IH
Lichen - Falsebox	L-F
Lichen - Moss	L-M
Lichen - Pink mountain-heather	L-PMh
Lichen - Prince's pine	L-PP
Lichen - Salal	L-Sl
Moss	M
Moss - Dull Oregon-grape	M-DOg
Moss - Falsebox	M-F
Moss - Kinnikinnick	M-K
Mountain-heathers	Mh
Oak fern	OF
Ocean-spray - Tall Oregon-grape	Os-TOg
Rosy twistedstalk - Five-leaved bramble	RT-FlB
Salal - Dull Oregon-grape	Sl-DOg
Salal - Huckleberry	Sl-H
Salmonberry - (Devil's club)	Sb-DC
Sitka valerian - Arnica	SV-A
Skunk cabbage	SC
Sphagnum	Sp
Sphagnum - Deer fern	Sp-DF
Sphagnum - Hardhack	Sp-Hh
Sword fern	SF

Biogeoclimatic Units		Soil Moisture Regime (Potential Hygrotope)[2]							
		0	1	2	3	4	5	6	7
CDFa[3] (CDFmm[4])	A B C D E	Lichen - Moss	California Brome		Salal - Huckleberry		Moss		Sphagnum - Hardhack
			Ocean-spray - Tall Oregon-grape		Salal - Dull Oregon-grape		Sword Fern		Skunk Cabbage
CDFb (CWHxm1)	A B C D E	Lichen - Salal		Salal - Huckleberry			Moss		Sphagnum - Hardhack
		Ocean-spray - Tall Oregon-grape		Salal - Dull Oregon-grape			Sword Fern / Salmonberry[5]		Skunk Cabbage
CWHa1 (CWHxm2)	A B C D E	Lichen - Salal	Salal - Huckleberry		Huckleberry - Moss		Deer Fern		Sphagnum - Hardhack
			Moss - Dull Oregon-grape				Sword Fern / Salmonberry[5]		Skunk Cabbage
CWHa2 (CWHdm)	A B C D E	Lichen - Prince's Pine	Salal - Huckleberry		Huckleberry - Moss		Deer Fern		Sphagnum - Hardhack
			Moss - Dull Oregon-grape				Sword Fern / Salmonberry[5]		Skunk Cabbage
CWHb1 (CWHvm1)	A B C D E	Lichen - Salal	Salal - Huckleberry		Huckleberry - Moss		Deer Fern		Sphagnum - Deer Fern
					Moss		Sword Fern / Salmonberry[5]		Skunk Cabbage
CWHb2 (CWHvm2)	A B C D E	Lichen - Moss	Moss	Huckleberry - Moss		Deer Fern		Sphagnum - Deer Fern	
						Rosy Twistedstalk - Five-leaved Bramble		Skunk Cabbage	
CWHb3 (CWHmm1)	A B C D E	Lichen - Salal	Salal - Huckleberry		Huckleberry - Moss		Deer Fern		Sphagnum - Deer Fern
			Salal - Dull Oregon-grape		Moss		Sword Fern / Salmonberry[5]		Skunk Cabbage
CWHb4 (CWHmm2)	A B C D E	Lichen - Moss	Huckleberry - Moss				Deer Fern		Sphagnum - Deer Fern
			Huckleberry - Dull Oregon-grape				Rosy Twistedstalk - Five-leaved Bramble		Skunk Cabbage
CWHb5 (CWHms1)	A B C D E	Lichen - Falsebox	Moss - Kinnikinnick		Huckleberry - Moss		Deer Fern		Sphagnum - Deer Fern
					Huckleberry - Rosy Twistedstalk		Oak Fern		Skunk Cabbage
CWHc1 (CWHds1)	A B C D E	Lichen - Prince's Pine			Moss - Falsebox		Moss		Sphagnum
		Ocean Spray - Tall Oregon-grape			Moss - Dull Oregon-grape		Oak Fern		Skunk Cabbage
CWHd1 (CWHvh1)	A B C D E	Lichen - Salal	Salal - Huckleberry				Deer Fern		Sphagnum
			Moss				Sword Fern		Skunk Cabbage
MHa	A B C D E	Lichen - Pink Mountain-heather	Huckleberry - Moss			Deer Fern		Sphagnum - Deer Fern	
			Huckleberry - Rosy Twistedstalk			Rosy Twistedstalk - Five-leaved Bramble		Skunk Cabbage	
MHb	A B C D E	Lichen - Pink Mountain-heather		Black Huckleberry - White-flowered Rhododendron	Huckleberry - Moss		Deer Fern		Sphagnum - Deer Fern
					Huckleberry - Rosy Twistedstalk		Rosy Twistedstalk - Five-leaved Bramble		Indian Hellebore
MHp	A B C D E	Lichen - Pink Mountain-heather	Mountain-heathers		Black Huckleberry - White-flowered Rhododendron		Sitka Valerian - Arnica		Indian Hellebore

1. Soil nutrient regime: A = very poor, B = poor, C = medium, D = rich, E = very rich
2. Soil moisture regime (Potential hygrotope): 0 = very xeric, 1 = xeric, 2 = subxeric, 3 = submesic, 4 = mesic, 5 = subhygric, 6 = hygric, 7 = subhydric
3. Codes for biogeoclimatic units from Green *et al.* (1984)
4. Revised codes for biogeoclimatic units 1988 (D. Meidinger, personal communication)
5. The Salmonberry (Devil's Club) type replaces the Sword Fern type on sites with a high water table.

Figure 17. Relationships of the understory types to the biogeoclimatic units and edatopes.

Table 3. Special habitats of Vancouver Island and the coastal mainland of southern British Columbia

Special habitat	Code
Alpine and subalpine meadows	AM
Riparian areas	Ri
Rock outcrops	RO
Vegetated slides	VS
Wetlands	W

Successional Stages

The previous section showed that it can be helpful to classify complex patterns of vegetation into simple abstract units such as understory types. So it is also helpful to clarify complex patterns of change in plant communities through time.

After a disturbance that removes the canopy of a coastal forest (e.g., logging or a severe fire), a new plant community quickly becomes established, beginning the process of secondary succession. If the new community remains undisturbed it will develop for hundreds of years, through many transitions in structure and composition, until it reaches a steady state or "climax" condition. The comings and goings of each plant species and the subtle changes in dominance are far too numerous to allow resource managers to recognize and catalogue each one. For long periods during the process of succession toward the climax, however, relatively homogeneous conditions persist. These periods are often classified by plant ecologists into seral or successional stages (e.g., Hamilton 1988; Luttmerding *et al.* 1990). Taking their lead and that of several other authors of handbooks on forest wildlife management (Thomas 1979; Harcombe 1984; Brown 1985), we have adopted a simple classification of successional stages to help organize our discussion of natural and man-made changes in forest stands. This classification draws heavily on existing schemes, but is somewhat modified to provide a level of detail appropriate to the successional changes that most affect deer and elk.

The five successional stages referred to in this handbook (Figure 18) are defined as follows:

Herb: Usually begins the first growing season after disturbance of the previous stand (or after slashburning) and lasts for 2-5 years. The plant community is dominated by herbs but may retain up to 30% cover of shrubs and small trees that persist from the previous stand.

Shrub - Seedling: Usually follows the herb stage, but may occur immediately following logging if abundant shrubs and small conifers remain. This stage is typified by extensive cover (>30%) of shrubs and trees smaller than 2.5 cm dbh, and normally lasts 3-20 years. Herbs and ferns often remain abundant.

Sapling - Pole: Follows the shrub-seedling stage, and persists 10-50 years. Trees are 2.5-20 cm dbh, and therefore not merchantable. During early years in this stage, stands are usually open-crowned, with an abundant understory consisting of a mixture of shrubs, ferns, and herbs. On most sites, the tree canopy will eventually close unless the stand is thinned, and the understory may disappear almost completely.

Young/Mature Timber: This is a long-lasting stage typified by co-dominant trees larger than 20 cm dbh. Self-thinning is under way in dense stands, and stands often diversify into dominant, co-dominant, and suppressed layers. If conifers are most abundant, they may be either long-lived pioneers or climax species such as western hemlock. Rates of tree growth vary widely depending on stand age. Little

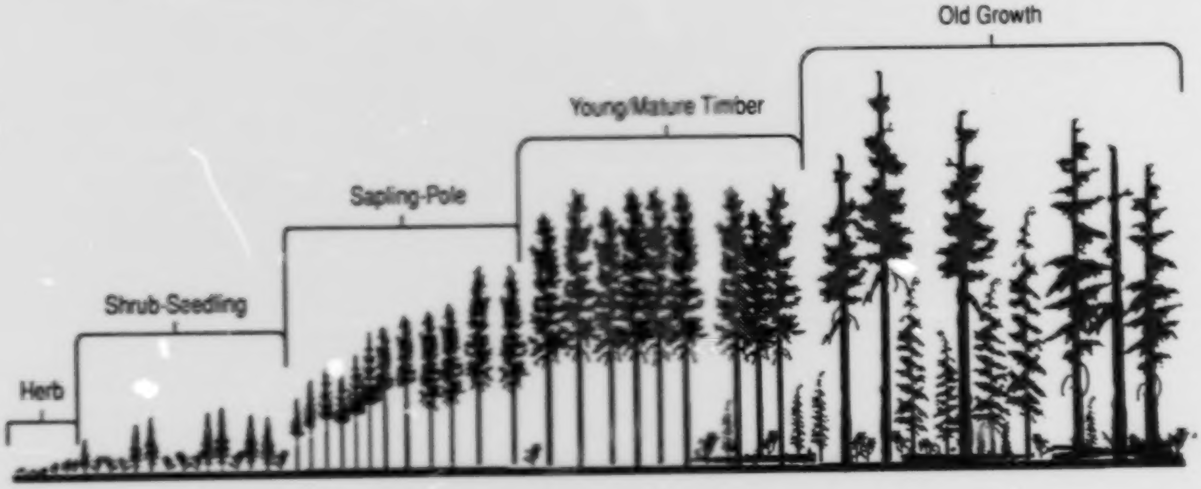


Figure 18. Successional stages as defined in this handbook.

decay is evident. Understory vegetation is usually sparse until late in the stage, when the first extensive mortality and decline in tree vigour begin.

Old Growth:
Lacking a precise definition for old growth in British Columbia, we use the term to refer to both over-mature seral stands (Luttmerding *et al.* 1990) and true climax forests. The old-growth stage often lasts hundreds of years, until a major disturbance clears the site of large trees. Old-growth stands are patchy and multi-layered. Extensive mortality of the large trees is evident, and snags and large down logs are common. Understory vegetation is abundant but spotty, growing most vigorously under canopy gaps. Canopy closure is less than 90%, often as low as 55-70%.

The correlation of these categories to others used in British Columbia is illustrated in Figure 19.

This simple classification of successional stages provides a convenient framework for later discussion of habitat values and forest management practices, especially in Chapter 5.

This handbook	Luttmerding *et al.* 1990	Harcombe (1984)	Hamilton (1988)
Herb	Pioneer seral	Grass-forb	Shrub-herb
Shrub - Seedling		Shrub-seedling	
Sapling - Pole		Pole-sapling	Pole-sapling
Young/Mature Timber	Young seral	Young seral	Young forest
	Maturing seral	Mature seral	Mature forest
Old Growth	Overmature seral	Old growth	Old growth
	Maturing climax		

Figure 19. Relationship between successional stage classifications used in this handbook and those of other authors.

HANDBOOK STRUCTURE AND CONTENT

The different types of information presented in this handbook are organized into three components. Chapters 1 through 5 provide the background knowledge needed for managing habitat; Chapter 6 describes a procedure for systematically assessing habitat condition and for choosing appropriate management actions; and the Appendices contain reference materials.

The four chapters that follow this one cover animal ecology, forestry interactions, and habitat management. The first two describe the ecological principles governing use of habitat by deer and elk, and emphasize how the animals use different habitats to meet their needs throughout the year. Chapter 4 describes the effects of timber management activities, such as logging, on habitat and, conversely, discusses how animals and their management impinge upon timber programs. This information should assist managers in adapting the habitat management techniques presented in Chapter 5, to tailor them to real-life situations. Chapter 5 describes, for each snowpack zone and seasonal range, the menu of techniques available for managing habitat to meet specific objectives.

Chapter 6, "Applying the Handbook to Habitat Management Planning," fills two roles. First, it describes a procedure to help users in systematically applying the handbook to everyday management of timber and wildlife resources. The procedure covers the whole planning process, from assessment of existing habitat, through identification of opportunities and problems, to selection and implementation of appropriate management actions. Second, it provides a simple example to show how the procedure and the information in other chapters can be applied in preparing a 5-year plan for timber development that incorporates a habitat management strategy for deer and elk.

The Appendices provide supporting information of two types: 1) detailed technical information, including values to deer and elk of the understory types and special habitats; and 2) reference materials, including a glossary of forestry and wildlife terms, and a list of Latin and common names.

Together, the three components of the handbook provide a habitat management "toolbox" from which the useful pieces can be drawn as needed.

A Note on Terminology

Many technical terms used in forestry and wildlife management in British Columbia have multiple definitions or local meanings, and hence they may not be clear to all readers. Examples are the terms "winter range" and "juvenile spacing." We have tried to maintain clarity and consistency by providing a glossary (Appendix 3) with definitions that are widely accepted internationally. Whenever possible, forestry terms were drawn from the standard international terminology recommended by the United Nations (UN) and the International Union of Forestry Research Organizations (IUFRO) (Ford-Robertson 1983). Where local synonyms are more commonly used in British Columbia, such as "site rehabilitation" rather than the UN-IUFRO term "species conversion," the local term appears in parentheses following the first use of the preferred term from the international terminology.

Chapter 2
Ecology of Black-tailed Deer

by
F.L. Bunnell

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INTRODUCTION

This chapter introduces the basic ecological relations between black-tailed deer and their environment. With Chapter 3 ("Ecology of Roosevelt Elk"), it sets the stage for discussion of interactions between the animals and forestry practices. Most of the relations are dealt with briefly here, but special attention is given to the effects of changing seasons and snow conditions, and to the ways in which changes in forest structure alter ecological relations.

Managers have three potential ways of manipulating deer numbers: 1) altering hunter harvest, 2) controlling natural predators and diseases, and 3) modifying habitat. Hunters, predators, and diseases can have substantial effects on deer populations, but the effects are usually of short duration (Wallmo 1981a). Changes in habitats, however, are often long-lasting and determine the ultimate capacity of the environment to support deer (Wallmo and Schoen 1981).

DISTRIBUTION

The Columbian black-tailed deer is one of three closely related subspecies occurring in British Columbia. At the northern end of its range, near Rivers Inlet, it intergrades imperceptibly with the Sitka black-tailed deer (*Odocoileus hemionus sitkensis*). South of Rivers Inlet, the Columbian black-tailed deer occurs on most islands, including Vancouver Island, and ranges east to near the summits of the Cascade and Coast ranges where it meets the third subspecies, the Rocky Mountain mule deer (*O. h. hemionus*) (Figure 20). In the United States, the Columbian black-tailed deer ranges through Washington and Oregon (generally west of the Cascade summit) into California.

Only the Columbian black-tailed deer occurs on the southern coast of British Columbia, where it inhabits forest lands at all elevations. During summer, some deer migrate into subalpine and alpine areas, well above forested ecosystems (Cowan 1956; Harestad 1979).

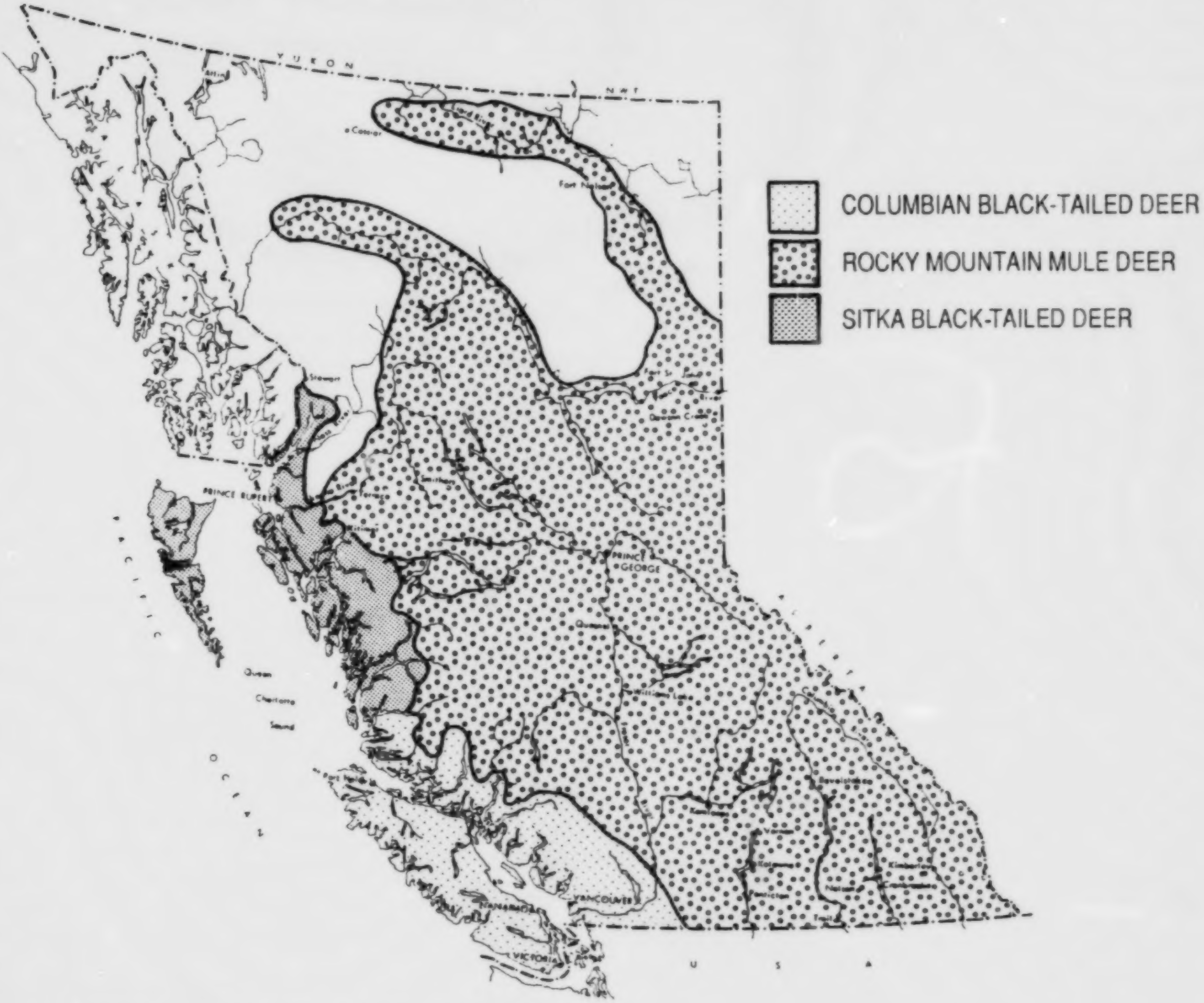

YUKON
N.W.T.
Cassiar
Fort Nelson
Stewart
PRINCE RUPERT
PRINCE GEORGE
PACIFIC OCEAN
Queen Charlotte Sound
ALBERTA
NANAIMO
VANCOUVER
VICTORIA
U S A
COLUMBIAN BLACK-TAILED DEER
ROCKY MOUNTAIN MULE DEER
SITKA BLACK-TAILED DEER

Figure 20. Distribution of black-tailed deer in British Columbia.

DESCRIPTION

On the southern coast, adult female deer generally weigh 35-45 kg in the summer and fall, but on excellent range they may weigh 50-60 kg. Males are larger, 50-110 kg, with the largest ones coming from the fertile lower Fraser Valley and from migratory populations elsewhere that obtain good forage at high elevations in summer and early fall.

Range quality affects antler development as well as body size. Male fawns (i.e., deer less than 1 year old) do not develop antlers but the pedicels, from which future antlers will grow, may be visible at close range. As yearlings (i.e., between 1 and 2 years of age), about 90% of the males are "spikes" with long single-point antlers, and about 10% have an additional point on each side. By 2.5 years of age, most bucks have forked antlers with two points on each side, and by 4.5 years bucks on good range usually have three or more points per antler. On poor range, or when populations are at high densities, many adult bucks attain only forked antlers.

Columbian and Sitka blacktails can be distinguished from each other only by skull measurements (Cowan 1956; Wallmo 1981b), but both subspecies differ markedly from the Rocky Mountain mule deer or "muley." The most apparent differences are that black-tailed deer have smaller bodies, smaller ears (about 3 cm shorter), and a largely black tail surrounded by a smaller white rump patch (Figure 21). Less apparent differences include a browner cast to the black-tailed deer's winter coat, smaller glands on the hock, and some variations in skull characteristics. The extent of these differences has led some workers to conclude that Columbian and Sitka blacktails represent a "species in the making" (Cowan 1956, p. 339).

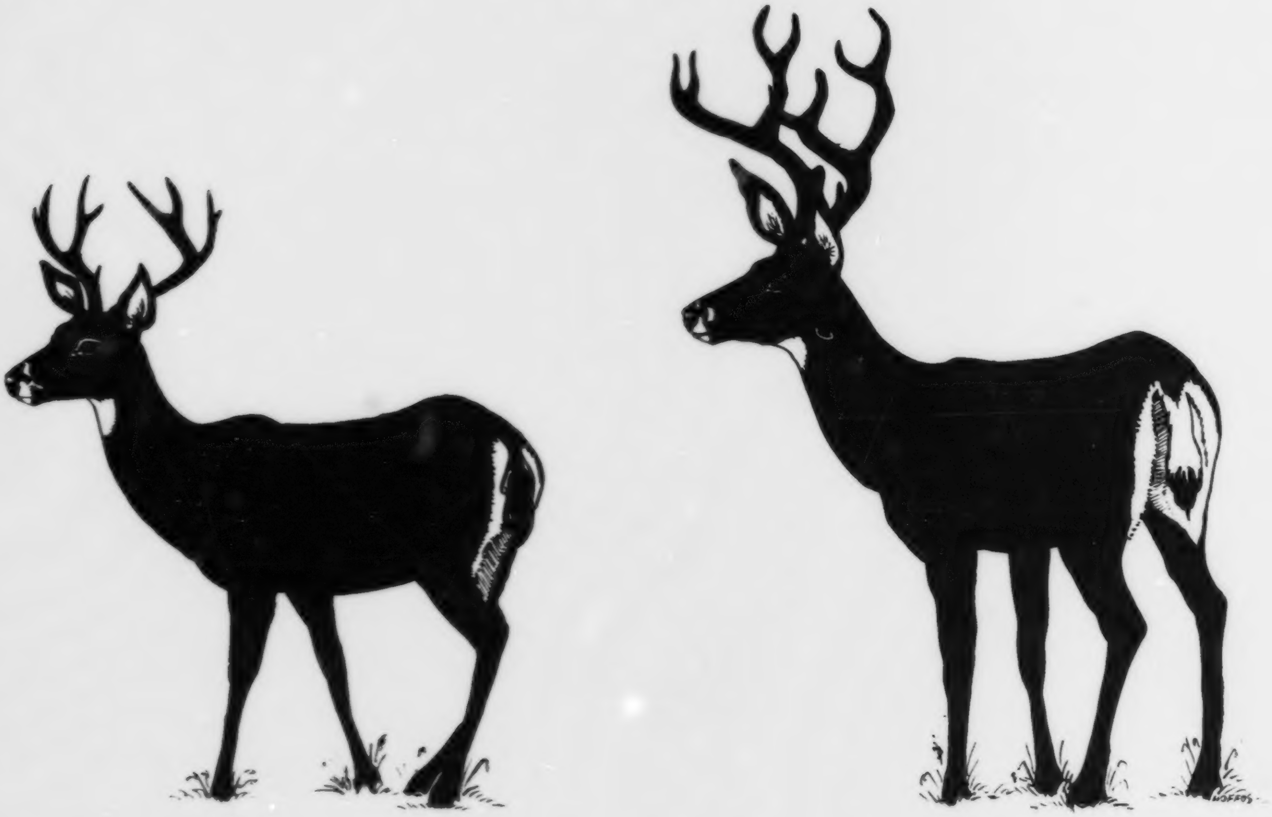


Figure 21. Columbian black-tailed deer (left) differ from mule deer (right) in having shorter ears, smaller antlers and bodies, and largely black tails with small white rump patches.

SOCIAL BEHAVIOUR

Black-tailed deer are not herding animals and usually do not move as large groups. They sometimes form large feeding aggregations on favourable clearcuts or winter ranges, but these aggregations are not cohesive. Small groups of three or four animals may move together through much of the year; these are usually family groups consisting of a mother and her young of the current and previous years. The species is far more solitary in nature than are elk.

Populations are the basic management or treatment units used by wildlife managers. Because deer move about readily and live alone or in small groups for most of the year, the concept of population is only a useful abstraction; there are no sharp boundaries between deer populations in coastal British Columbia. Typically, biologists speak of the deer inhabiting a given geographic area, such as a watershed, as a population.

Black-tailed deer are among the most difficult big game species to count, so absolute abundance is not used to assess the size or trend of a deer population. Managers must rely on indices of abundance that reflect population size or animal health (e.g., roadside counts or body-fat indices) and the product desired from the population (e.g., recreational days expended by people hunting and viewing deer).

LIFE HISTORY

Columbian blacktails are heaviest about the time of the rut in mid-November to early December, but through most winters adults lose weight, often as much as 20-25% of their peak fall weight. Antlers are usually shed by January and regrown during summer (Figure 22).

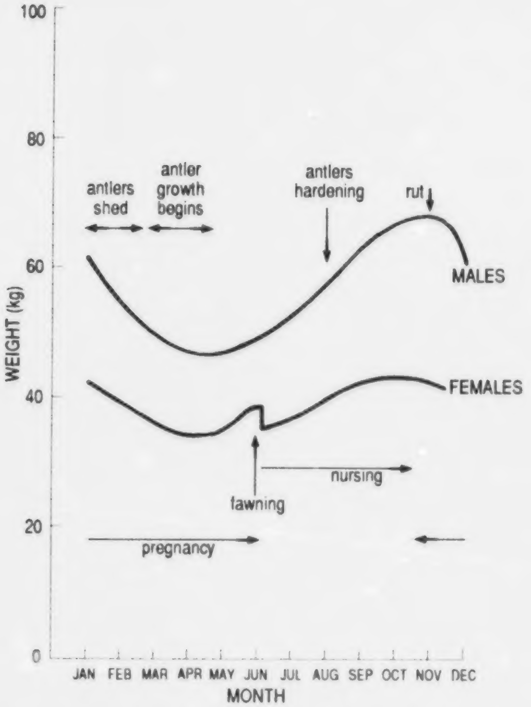


Figure 22. Annual cycle of weight, reproductive activity, and antler growth in adult Columbian black-tailed deer.

Vancouver Island blacktails breed during November and early December, with most does conceiving during their second ovulation, from November 15 to December 5 (Thomas 1970). Does are receptive for a short period (about a day) during estrus (Wallmo 1978). If not bred, they go through additional estrus cycles, which usually occur in 22- to 29-day intervals (Thomas and Cowan 1975). As bucks may follow a doe for 2 or 3 days prior to the heat period and then accompany her for 3 or 4 days after mating, a buck is not likely to service more than three or four does during a 28-day period (Halls 1978; Geist 1981).

Births occur about 200 days after conception, concentrated in the first half of June. Fawns rarely conceive in the wild, but 45-80% of the yearlings usually become pregnant, the percentage depending on nutritional conditions. The conception rate in deer 2 years old and older is often 90-95% (Bunnell 1987). On good ranges the contribution of these older does averages about one and a half fawns each (Figure 23).

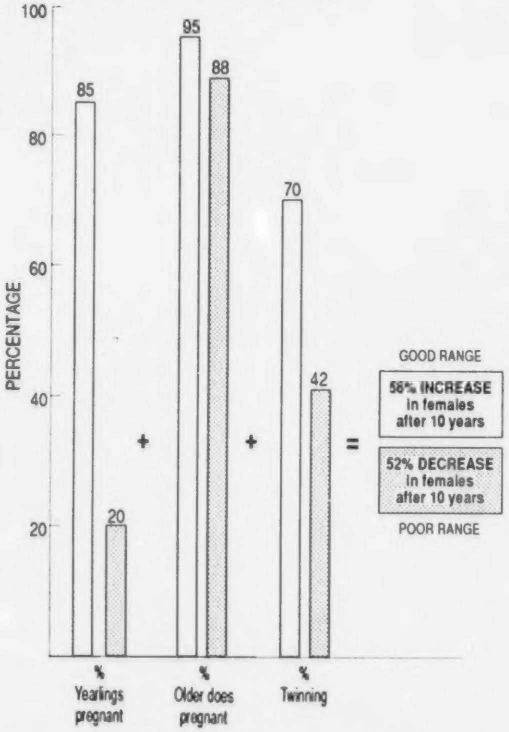


Figure 23. Quality of the range can greatly affect rates of reproduction and population growth (data of Bunnell 1987; population projection assumes 30% adult mortality, 50% fawn mortality, and does not living longer than 10 years).

This high potential for growth is reduced by mortality, which can be significant during severe winters or when predators are abundant. The effect of a severe winter is particularly sudden and dramatic because many deer die during winter or early spring and the surviving females produce fewer fawns than normal. Since 1975, the long series of mild winters has produced relatively low rates of mortality due to winter stresses, and wolf predation has been the major mortality factor limiting deer populations on Vancouver Island (reviewed by Janz 1989). Hatter (1988) documented a 63% mortality rate of radio-collared fawns by the end of August, of which two-thirds was attributed to wolf predation. Adult mortality due to wolf predation can also be significant. McNay and Doyle (1987) estimated annual mortality rates for adult does averaging 23% before wolf removal, and 4% after.

Because of the abundance of security cover in coastal ecosystems, hunting has little effect on black-tailed deer herds compared to habitat quality and predation. Even with liberal hunting seasons, there is little chance of overharvest (Smith 1968; Connolly 1981). Concern can arise, however, where hunting mortality becomes additive to other major sources of mortality such as predation.

The impact of parasite infestations on black-tailed deer populations is poorly known. In a sample of 55 deer from Vancouver Island, an average of six species of parasites per deer (maximum of 11) was reported by Cowan (1951). A few species are known to be important contributing factors to winter kill, including the deer botfly (*Cephenemyia jellisoni*), caecum worm (*Oesophagostomum venulosum*), and thread lungworm (*Dictyocaulus viviparus*). Other species, such as the thin-necked bladderworm (*Cysticercus tenuicollis*), can have very high incidence rates but apparently are not pathogenic. It is generally accepted that outbreaks of parasitic diseases and their contributions to animal mortality are related to nutrition and condition of the host. Maintenance of good-quality habitat and prevention of overcrowding helps minimize the effects of parasites and disease (Cowan 1951).

The life expectancy of coastal deer varies widely and depends largely on weather, habitat condition, predation, and hunting pressure. Few deer live beyond 10 years. Harvest information collected at the Campbell River road check from 1976 to 1980 indicated that only 4% of harvested bucks and 12% of does were older than 5.5 years. Mean ages of harvested deer were 2.5 years for bucks and 3.2 years for does.

Generally, mortality is highest among fawns (45-70% per year) and lowest among adult females (15-25% per year). Bucks are hunted more heavily than does and their mortality rates (from all causes) range from 20 to 50% per year. The combined effects of reproductive and mortality rates permit blacktail populations to grow over 25% per year under favourable conditions or decline by as much as 40% per year under particularly unfavourable conditions (Figure 24).

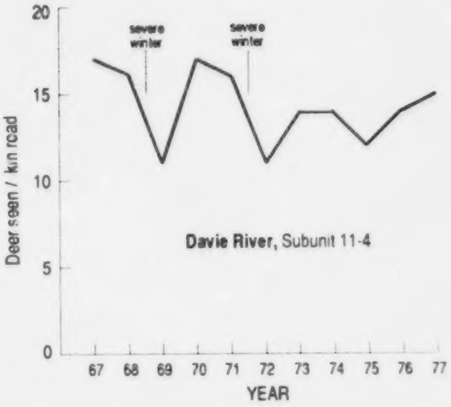


Figure 24. Population trend data from the Nimpkish River valley show the variability in population growth rates common to black-tailed deer (from Jones and Mason 1983).

DEER REQUIREMENTS

Deer have three basic requirements: food, water, and cover. Most of the concerns about deer habitat result from the ways that forest management affects these requirements.

Food

Deer obtain a portion of their water and all of their energy, protein, vitamins, and minerals from their food. In southwestern British Columbia, both digestible energy and nitrogen (for building protein) are scarce enough to limit deer abundance or health in specific seasons on many ranges (Bunnell *et al*. 1978; Rochelle 1980). Phosphorus also may be limiting in some areas (Ellis 1984), but there is no evidence that vegetation is deficient in other nutrients.

Energy is necessary to run the processes or "deer machinery"; proteins are necessary to build and service the machinery. Proteins are critical structural components, important in reproduction and growth. They are also active as enzymes, hormones, and transport mechanisms in the body. To provide sufficient energy and protein, both quantity and quality of forage are important.

In most plants the chemical composition of stem and leaf tissue and the places where nutrients are stored change markedly with the seasons. During spring most of the important nutrients in newly grown material are simple compounds located in cell sap, where they are readily digestible (see Figure 25). As plant tissue ages, potential nutrients become more complex and are stored in the walls of cells where they are less digestible. As the season progresses further, these walls toughen by adding lignin and become increasingly indigestible.

Some plants hold more energy in indigestible compounds than others. Forbs, such as fireweed (*Epilobium angustifolium*) contain less fibre, so more of the energy in them is digestible. The higher quality of these plants results from the manner in which changes in plant composition interact with the rumen fermentation process or digestive physiology of deer. This interaction has important implications for habitat management, and is discussed in later sections of this chapter.

Digestive physiology

Nutritional deficiencies result from the ways in which the digestive system of deer interacts with seasonal changes in the chemical composition of their foods. In the rumen, the first chamber of the four-chambered stomach found in deer and other ruminants, microbes ferment the food before it passes to the fourth chamber (the abomasum) where enzymatic digestion typical of human stomachs begins. One beneficial result of ruminal fermentation is that deer can partially digest complex carbohydrates, such as cellulose, that many mammals cannot use.

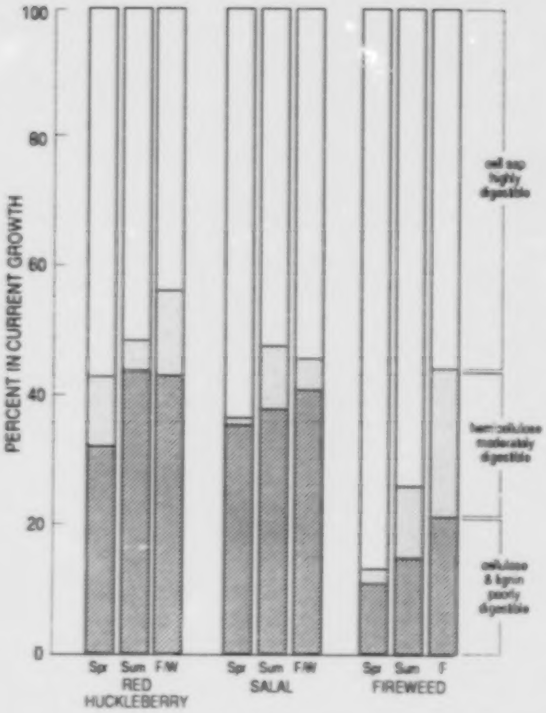


Figure 25. The proportion of highly digestible material in forage plants varies with the seasons and among plant species. Data summarized from Rochelle 1980.

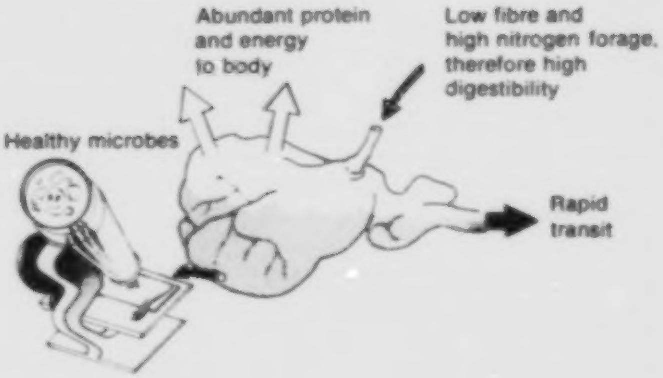
However, as new plant growth ages, the proportion of available nitrogen decreases, the complexity of carbohydrates increases (e.g., from starch to cellulose), the amount of partially digestible fibre or cell wall increases, and the proportion of indigestible fibre (lignin) increases. As this occurs, the amount of calories deer can extract and the rate at which these are extracted decline. Rumen fermentation then slows, less energy is available, food stays longer in the rumen, and the deer's intake of all nutrients is restricted.

As a result, most vascular plants are far less valuable to deer in winter than in spring and summer. As they age, some plants also develop secondary compounds, such as tannins or other phenolics, which further reduce digestibility.

If rumen microbes can obtain only small amounts of energy from incoming food, the rate at which they synthesize protein is also reduced (Figure 26). Much of the protein used by deer comes from microbes in the rumen. Furthermore, amounts of nitrogen in the forage can fall so low that microbes can no longer synthesize protein or ferment cellulose at a rate sufficient to maintain deer. There may be abundant food, but if its quality is poor, deer can starve with their stomachs full.

The volume of a ruminant's "fermentation tank" (rumen-reticulum) increases with the animal's weight (Bunnell and Gillingham 1985); and that for a deer is only about 30% the size in elk. Elk can consume greater amounts of less digestible forage than deer without filling their rumens and seriously reducing the amount of energy obtained per unit time. To be productive, deer must eat more highly digestible forage than elk, and the narrower mouth of deer permits them to be more selective of high-quality plant parts. These are the major reasons for differences in forage use by deer and elk.

SPRING AND EARLY SUMMER DIET


Abundant protein
and energy
to body
Low fibre and
high nitrogen forage,
therefore high
digestibility
Healthy microbes
Rapid
transit

DIET DURING SEVERE WINTERS

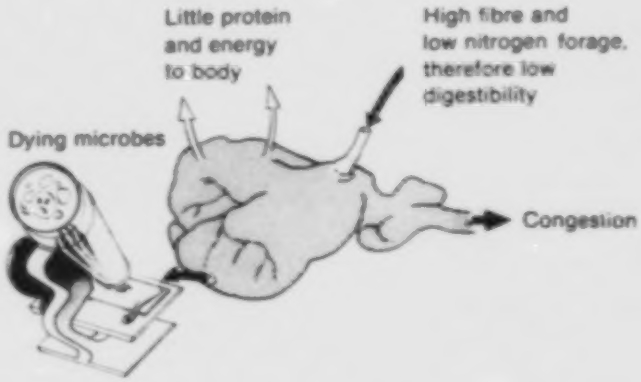

Little protein
and energy
to body
High fibre and
low nitrogen forage,
therefore low
digestibility
Dying microbes
Congestion

Figure 26. The low-quality diets available during severe winters yield little protein and energy even if deer are able to fill their rumens with food.

Diet selection and forage quality

Because the diverse microbes in the rumen differ in their abilities to ferment chemical compounds, deer benefit from a diverse diet. As a result, studies of deer food habits commonly yield a long list of foods eaten (e.g., Cowan 1945; Gates 1968). Table 4 lists the most important forage species for each season, and Table 5 provides estimates of the relative forage-producing capabilities of the understory types. Forage preferences are determined, in part, by seasonal variations in forage digestibility and protein content and by nutritional requirements of the animals.

As the digestibility of forage declines below the 50% level, energy intake declines rapidly, primarily because it takes longer for food to pass through the animal (Robbins 1983: 321). As the protein content of forage falls below 7%, deer develop slowly and produce fewer healthy fawns. A value of 7-10% protein is probably adequate during seasons of maintenance (late fall and winter), but protein contents should be at least 16% for optimum growth and production during the spring and summer (Verme and Ullrey 1972, 1984).

Winter forage

In winter, western redcedar, deer fern, bunchberry, and the arboreal beard lichens *Alectoria* and *Bryoria* provide highly digestible forage (Figure 27). Salal is not digested well when eaten alone, but when eaten with other species (especially *Alectoria*) its digestibility is higher (Rochelle 1980), and salal is an important winter

Table 4. Important forage plants for Columbian black-tailed deer in southern British Columbia.[a] The most important or preferred species are printed in bold type. The length of the winter forage list reflects the seasonal emphasis of the studies from which the table was compiled, rather than a greater diversity of diet during winter. Deer eat many more species in spring and summer, so the diet in any one area is seldom dominated by a few species.

	Winter forage	Spring forage	Summer forage
Trees:	**Douglas-fir** western hemlock **western redcedar**	bigleaf maple **Douglas-fir**	red alder
Shrubs:	Alaskan blueberry five-leaved bramble kinnickinnick oval-leaved blueberry **red huckleberry** rose spp. **salal** saskatoon twinflower vine maple willow spp.	***Rubus* spp.** (salmonberry, blackberry, thimbleberry, raspberry, bramble) salal **willow spp.**	**salal** willow spp.
Ferns:	**deer fern**	**bracken**	
Herbs:	bunchberry grass spp.	bunchberry **fireweed** grass spp. hairy cat's-ear horsetail **pearly everlasting**	**fireweed** grass spp. hairy cat's-ear **pearly everlasting**
Arboreal lichens:	***Alectoria*** ***Bryoria*** *Lobaria oregana* ***Usnea* spp.**		

[a] References: Cowan 1945; Gates 1968; Jones 1975; Rochelle 1980; IWIFR Program, unpubl. data; B.C. Min. Environ., unpubl. data.

Table 5. Relative values of each understory type for potential production of deer forage. The forage values represent each type's potential at its peak of forage production.

Understory type	**Potential forage value**		
	Winter	**Spring**	**Summer**
Black huckleberry - White-flowered rhododendron	Low	Low	Low
California brome	Low	Moderate	Low
Deer fern	Moderate	Moderate	Moderate
Huckleberry - Dull Oregon-grape	Moderate	Moderate	Moderate
Huckleberry - Moss	Low	High	High
Huckleberry - Rosy twistedstalk	Moderate	High	High
Indian hellebore	Low	Moderate	Moderate
Lichen - Falsebox	Moderate	Low	Low
Lichen - Moss	Low	Low	Low
Lichen - Pink mountain-heather	Low	Low	Low
Lichen - Prince's pine	Moderate	Low	Low
Lichen - Salal	Moderate	Low	Low
Moss	Low	Low	Low
Moss - Dull Oregon-grape	Low	Moderate	Moderate
Moss - Falsebox	Low	Low	Low
Moss - Kinnikinnick	Low	Low	Low
Mountain-heathers	Low	Low	Low
Oak fern	Low	Moderate	Moderate
Ocean-spray - Tall Oregon-grape	Low	Low	Low
Rosy twistedstalk - Five-leaved bramble	Low	Moderate	Moderate
Salal - Dull Oregon-grape	High	Moderate	Moderate
Salal - Huckleberry	High	Moderate	Moderate
Salmonberry - (Devil's club)	Moderate	High	High
Sitka valerian - Arnica	Low	Moderate	Moderate
Skunk cabbage	Moderate	High	Moderate
Sphagnum	Low	Low	Low
Sphagnum - Deer fern	Low	Low	Low
Sphagnum - Hardhack	Low	Low	Low
Sword fern	Moderate	High	High

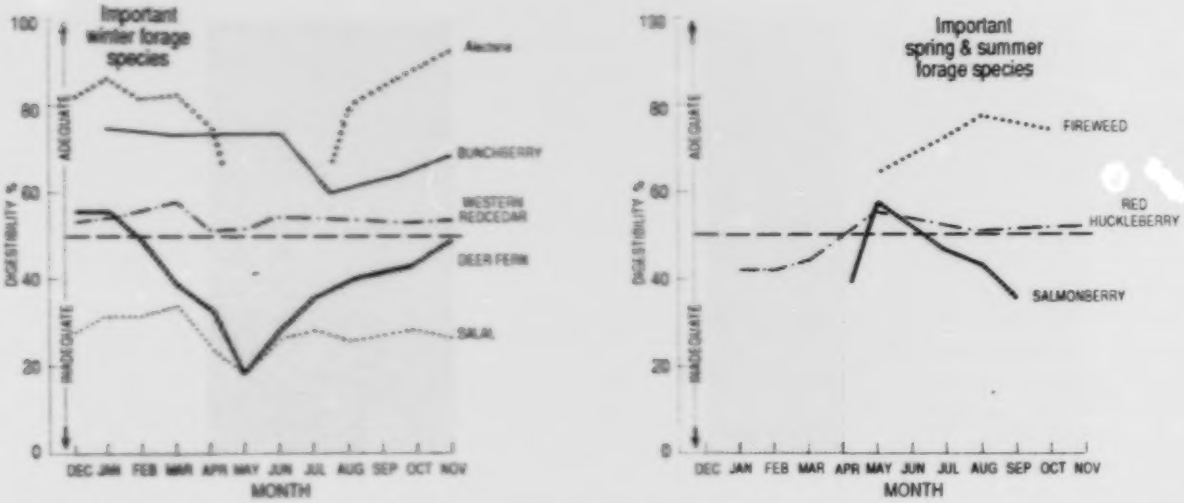


Figure 27. Trends in digestibility (available energy) of forage species through the year in the Nimpkish River valley. In other areas the phenology may differ. Data summarized from Rochelle (1980) and J.A. Rochelle and F.L. Bunnell (unpublished).

forage throughout the south coast. No major forage species provides high concentrations of crude protein through winter, but blueberries, deer fern, and sword fern exceed 7% and bunchberry exceeds 10% (Figure 28).

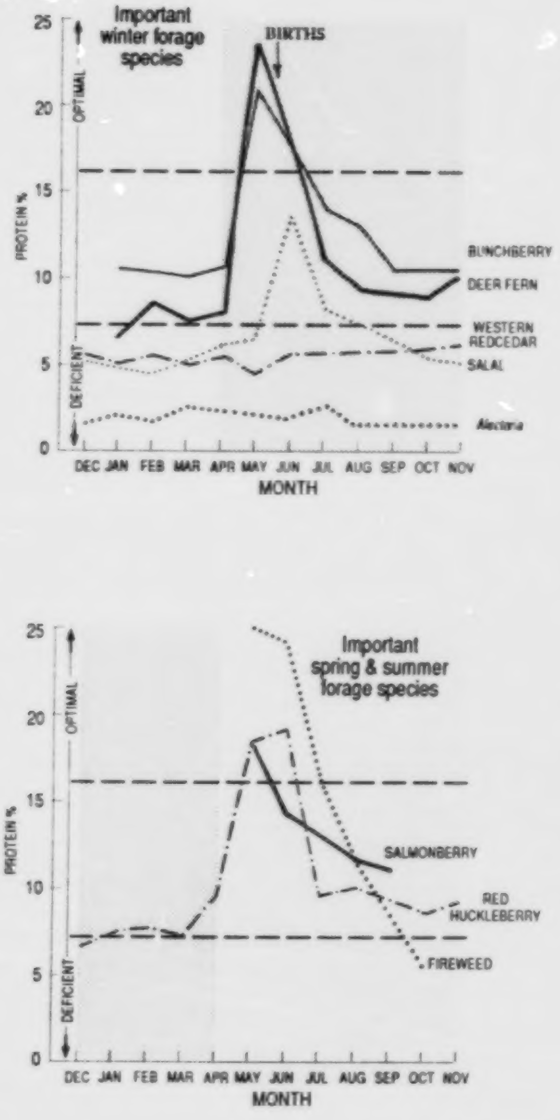


Figure 28. Trends in protein content of forage species through the year in the Nimpkish River valley. Data summarized from Rochelle (1980) and J.A. Rochelle and F.L. Bunnell (unpublished).

In the moderate and deep snowpack zones, the shorter winter forage species (e.g., deer fern and bunchberry) are often buried by snow, and taller shrubs may be as well. The height of key browse species, such as salal and huckleberry, is thus important on these winter ranges, as is the rate at which they are buried by snow. When all ground forages are buried, deer must rely on litterfall on top of the snow. The most digestible component of litterfall is arboreal lichen, especially species of *Alectoria*, *Bryoria*, and *Usnea*. During severe winters, arboreal lichens and the lower branches of western redcedar and Douglas-fir may be the major sources of food. Because winter forage is always low in quality and often low in quantity, by spring deer have experienced up to several months of energy and protein deficits. On northern Vancouver Island, female deer lose about 20-25% of their body weight over winter (Rochelle 1980; see Figure 22), and large males likely lose more.

Spring and summer forage

New spring forage is naturally high in protein and digestibility and, with spring green-up, many ephemeral forbs such as *Tiarella* and *Hypochaeris* appear. With these forbs, deer diets can become more diverse at the same time that the quality of forage is rising. The most digestible winter forage, arboreal lichens, provides very little energy (1.4 kcal/g) and protein (1.8%), but fireweed in the spring provides 4.1 kcal/g and 24.5% protein (Figures 27 and 28). Many other forbs, young ferns, and some shrubs, such as blueberries, exceed 50% digestibility and 16% protein. However, because pregnancy, lactation, and the replacement of weight lost over winter place high energetic and protein demands on deer, amounts of high-quality forage can be limiting. Important spring forage plants are fireweed, bunchberry, several *Rubus* species, and *Vaccinium*, but many herbs (including grasses) are used as well (Table 4).

Most preferred species remain above 50% digestibility throughout the summer (Figure 27), but by mid-summer protein contents have declined to 10% or less (Figure 28). Abundant readily digestible forage is important in summer, because deer are more likely to survive the oncoming winter if they can accumulate fat stores during summer and early fall. Because the quality of forage declines as plants mature through the growing season, deer migrating to higher elevations where the season is delayed can benefit from the earlier phenological stages that are more digestible. Forage quantity is greatest during summer, but the quality of most forages is no longer as high as it was during spring, so quality rather than quantity of forage becomes limiting. Deer diets become less diverse because deer feed more selectively. Important summer forage species are fireweed, salal, *Rubus*, blueberry, huckleberry, and, on some sites, willow and alder (Table 4).

Management implications

We have seen that forage quality changes seasonally, influencing the growth and reproduction of deer. Deer respond to the changes in plant abundance and chemistry by being selective in their feeding and by reducing energy expenditure during late fall and winter when their rates of energy intake decline.

These changes have three broad implications to habitat management. First, habitat managers can concentrate their efforts on a few high-quality species, but because forage quality is important to deer year-round, this group of species must include important forages for all seasons. Key forage species ideally should be ≥ 45% digestible during their season of use. Second, the total quantity of forage is most limiting during winter when many forbs are dead and shorter plants are buried by snow (Figure 29). At this time forage quality is also lowest. Management activities that increase the amount of good winter forage can therefore be an especially significant benefit. The provision of more digestible energy can reduce mortality and increase reproduction (Figure 30), thereby influencing the population substantially. Third, abundant high-quality forage is important during spring and summer when nutrient demands are greatest, and it often can be provided by highly digestible herbs growing in clearcuts or natural meadows.

Forestry practices such as harvesting, site preparation, regeneration, and stand tending can influence forage on all seasonal ranges (see Chapter 5).

Figure 29. Little forage is available in open areas during snowy winters.

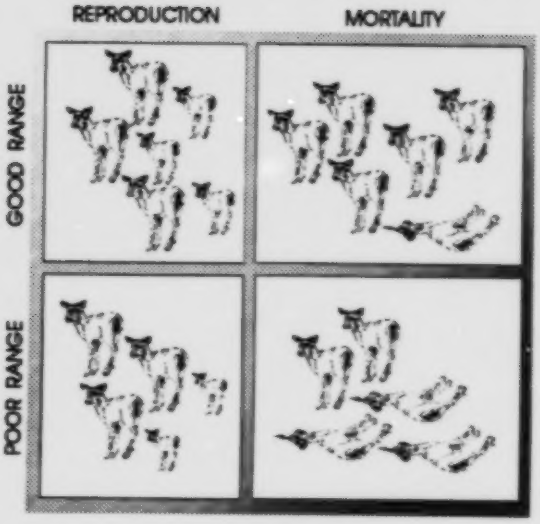


Figure 30. Good winter range provides a high level of available energy that counterbalances the effects of deep snow and cold weather.

Water

Deer require free water, but that requirement changes with their diet, physiological status, and thermal stress. Water requirements are greatest in late spring through early autumn when food consumption is high, forages are relatively dry, and warm temperatures cause deer to cool themselves by sweating and panting. Deer need less free water in early spring when forage is most succulent, because they can obtain much of their water from plant tissue. Water requirements of does increase in late spring with the demands of late pregnancy, and in summer with the demands of lactation. Except during the driest periods of summer, free water is probably not limiting in any part of coastal British Columbia. Forestry practices may, however, influence use of water sources by affecting the availability of forage and cover nearby.

Cover

Deer need or use cover for a variety of purposes. Forest cover influences several factors of great importance: 1) the availability of security from predators and humans; 2) the energetic costs of maintaining body temperature; 3) the abundance and height of rooted forage; 4) the rate at which forage is buried by snow; and 5) the costs of movement through snow. Deer take advantage of the beneficial influences of forest cover on these factors by selectively using areas of cover that satisfy their immediate needs for shelter. Three distinct cover types — security cover, thermal cover, and snow interception cover — are recognized by biologists in coastal British Columbia.

Security cover

The need for security cover is difficult to assess because it cannot be related directly to some energy cost experienced by the animal. Field observations show, however, that the use of cover for security is a ubiquitous behavioural response. Deer prefer to have cover close by even when they do not need it to reduce energy costs. This pattern is evident in deer use of clearcut areas, which declines with increasing distance from forest cover (see "Interspersion of Forage and Cover Areas," page 49 and Figure 31). Although security cover cannot be expressed as a discrete energy requirement, its provision close to other resources such as forage and water sources increases the utility of those resources and influences deer health and population abundance.

In forested areas, the major function of security cover is physical concealment of deer from hunters and predators. The foliage and trunks of trees provide some of the best security cover, but even short, dense vegetation and logs can provide concealment. Deer are sometimes found bedded in recent clearcuts with vegetation only 1.5-2 m tall. Variable topography can also provide security cover either by partially concealing deer (e.g., in swales) or by giving deer a commanding view in more open terrain.

Research with mule deer indicates that the most effective security cover will hide an average of 90% of a deer from view at 60 m distance or less (Thomas *et al.* 1979), and that security cover patches need to be 180 m or more in diameter to provide a suitable core area for hiding. These relations need to be evaluated for coastal black-tailed deer, but provide the only criteria now available for security cover.

Old growth with a patchy conifer understory and most well-stocked stands of young trees with live branches to the ground would satisfy security cover requirements. Dense thickets of young cedar or hemlock provide both thermal and security cover when they retain live branches within 2 m of the ground. Tree boles alone will provide security cover only in very dense stands where the sum of basal diameters per hectare exceeds 311 m (e.g., 10 000 trees per hectare averaging 3.11 cm dbh; Smith and Long 1987).

Figure 31. Deer prefer to remain near security cover when foraging in open areas.

Thermal cover

Air temperature, wind speed, solar radiation, and humidity combine to produce the operative temperature (Te) or the effective temperature experienced by an animal. For example, a Te of 38°C would be attained by black-tailed deer in still air at 15°C with 600 W/m^2 solar radiation. By definition, within its thermoneutral zone an animal expends a minimum amount of energy to maintain body temperature and tissue function. Above and below the limits of the thermoneutral zone, an animal must use additional energy to keep its "machinery" running and in good repair — for example, by sweating or panting when too warm and by shivering when too cold. Thermal cover modifies air temperature, wind speed, radiation, and humidity. It allows deer to expend less energy to regulate body temperature, thus making more energy available for growth and reproduction. A wide range of topographic and vegetative structures can reduce the energy costs of thermoregulation by acting as thermal cover (Bunnell *et al.* 1985b). For example, to reduce nighttime thermal costs during winter, the vegetation should: 1) entrap longwave radiation and maintain warmer air temperatures, requiring a closed canopy above 3 m height (i.e., above a deer's head); 2) reduce wind speed at deer height, requiring a forest stand or dense underbrush; and 3) intercept precipitation, requiring a closed canopy and large crown volume. But in daytime during winter, unshaded openings permit deer to receive direct radiation from the sun and warm up quickly even under cold air temperatures. Rocky bluffs provide exposure to both incoming radiation and back radiation from the rocks. As well, during summer, any vegetation that reduces incoming solar radiation is helpful in keeping body temperature in the thermoneutral zone.

The importance of thermal cover varies with the seasons, prevailing weather conditions, and age, size, and nutritional condition of the animal. Large animals have relatively small ratios of surface area to body weight and small convective heat losses. As a result, they use different tactics than smaller animals to maintain constant body temperature as Te changes. These differences are evident even in deer and elk. During summer, deer sweat minimally but begin panting (rapid open-mouthed breathing) at an air temperature of 27°C (Te = 36°C). Elk rarely pant to increase cooling by evaporation, but have extensive sweating capabilities (Parker and Robbins 1984). Both species fluff up their hair and begin shivering as temperature declines below the lower limit of the thermoneutral zone.

In winter, the lower boundary of the thermoneutral zone for yearling black-tailed deer is about -6°C in still air; the upper boundary is about 18°C (Figure 32). During summer when the haircoat is thinner and the metabolic rate is higher, lower and upper boundaries are about 12° and 27°C still air temperature, respectively. Wind, precipitation, and solar radiation can exaggerate or compensate for the energetic expenses of extreme temperatures. Larger, adult animals can cope with greater temperature extremes than can fawns.

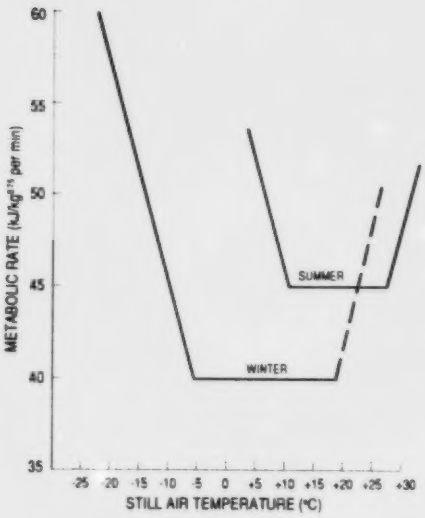


Figure 32. The metabolic rate of black-tailed deer is lower and the limits of thermoneutral zone occur at lower temperatures in winter than in summer. Derived from data of Parker 1988.

Requirements for thermal cover are often uncertain because of apparent differences between what deer prefer and what they need. The uncertainty results largely from tradeoffs influencing the animal's net energy balance. Without thermal cover, or without forests to intercept snow, deer spend more energy. If the deer can obtain sufficient additional energy by continuing to forage despite increased energy costs from lack of cover, there is no net need in terms of energy balance. But if forage is too scarce or poorly digestible, the expenditure of extra energy may cause death by starvation or reduced production of young in the spring.

The flexibility provided by these tradeoffs between forage and cover profits both deer and forest managers. For example, a deer's forage requirements may be lower if abundant thermal cover is available nearby; hence, it may be easier and more important in some situations for the habitat manager to provide more thermal cover than to provide more forage, especially in heavily cutover areas.

Snow interception cover

Energy costs of moving through snow are closely related to an animal's sinking depth, which is affected by three animal characteristics (leg length, foot loading, and velocity) and three snow characteristics (depth, density, and hardness) (Parker *et al.* 1984). As animals sink deeper, they expend more energy to lift their feet above the snow. Dense snow slightly reduces the depth to which they sink, but it also increases drag on their feet and, consequently, increases energy expenditure. Strong crusts in the snow can support the weight of a black-tailed deer or even elk, but weaker crusts produce an unstable, unfavourable substrate.

Once deer sink beyond approximately 40% of their chest height, energy expenditure increases rapidly (Figure 33). Sinking depths greater than 25 cm significantly restrict coastal blacktails, whose chest height is only about 57 cm in adults. Although deer can move (with difficulty) through 50-60 cm of uncrusted snow, an adult doe sinking only 30 cm expends about 6 times as much energy as one sinking 10 cm (Parker *et al.* 1984). Because its legs are shorter, a fawn sinking 30 cm would expend 8-10 times as much energy as one sinking 10 cm (Figure 33).

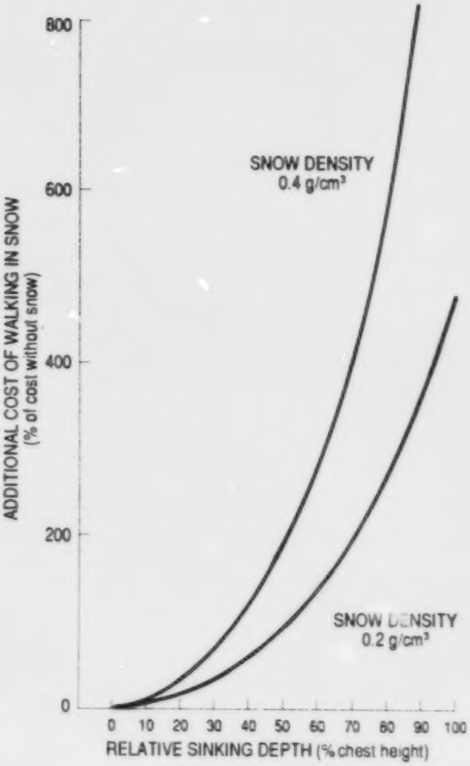


Figure 33. The energetic costs of walking in snow are affected by snow density, snow depth, and leg length of deer (derived from data of Parker et al. *1984). The chest height of adult black-tailed deer on Vancouver Island is about 57 cm.*

Because the costs of running through snow are high, animals attempt to minimize rapid retreat from disturbance by humans or predators during winter. This behaviour emphasizes the importance of security cover. When forage is scarce, deer may have difficulty finding the extra food needed to make up for the energy expended in running through snow.

Forest cover influences snow depth, density, and surface hardness. For example, snowfalls yielding a late winter accumulation of 50 cm of snow at a density of 0.3 g/cm^3 in a recent clearcut would yield only 5 cm in an adjacent conifer stand with 70% crown closure (Harestad and Bunnell 1981). For adult black-tailed deer, the relative increase in costs of moving through the snow as compared to bare ground would be 10% in the forest and about 500% in the clearcut.

In terms of influences on deer movement, dense young-growth (>10 m tall) and old-growth forests produce favourable snow conditions on the ground, but open young growth and clearcuts provide unfavourable conditions. The degree of canopy closure, measured as mean crown completeness (MCC) (Bunnell *et al.* 1985a), is the factor that exerts the most influence on the proportion of a snowfall that will be intercepted by a forest stand greater than 10 m tall (McNay *et al.* 1988). Stands with MCC levels of 60% and higher are far more efficient at intercepting snow than are more open stands. Forest stands have proportionately less effect on snowpack depth as total snowfall increases (Harestad and Bunnell 1981; McNay *et al.* 1988).

Because the crowns of large trees intercept snow efficiently and reduce the snowpack beneath, energetic costs of movement are reduced. The reduction in snowpack also reduces the rate at which forage is buried, especially for red huckleberry (Figure 34). Additionally, some young stands and most old-growth stands have gaps in their canopy caused by root rot, wind throw, or other natural mortality. These gaps encourage tall, often vigorous, shrub growth. Also, some shrubs such as salal, blueberry, and huckleberry can grow tall under canopies that are relatively closed (Bunnell and Jones 1984; Figure 34). In most old-growth stands with canopy closure greater than 60%, the combination of tall forage and a canopy that effectively reduces the costs of movement provides favourable winter range. Attempts at mimicking these features in young forests incorporate large trees with wide crowns, variable canopy closure, and small openings (0.5 to 1 tree-height wide) that accumulate little more snow than the forest (Bunnell *et al.* 1985a; Nyberg *et al.* 1986).

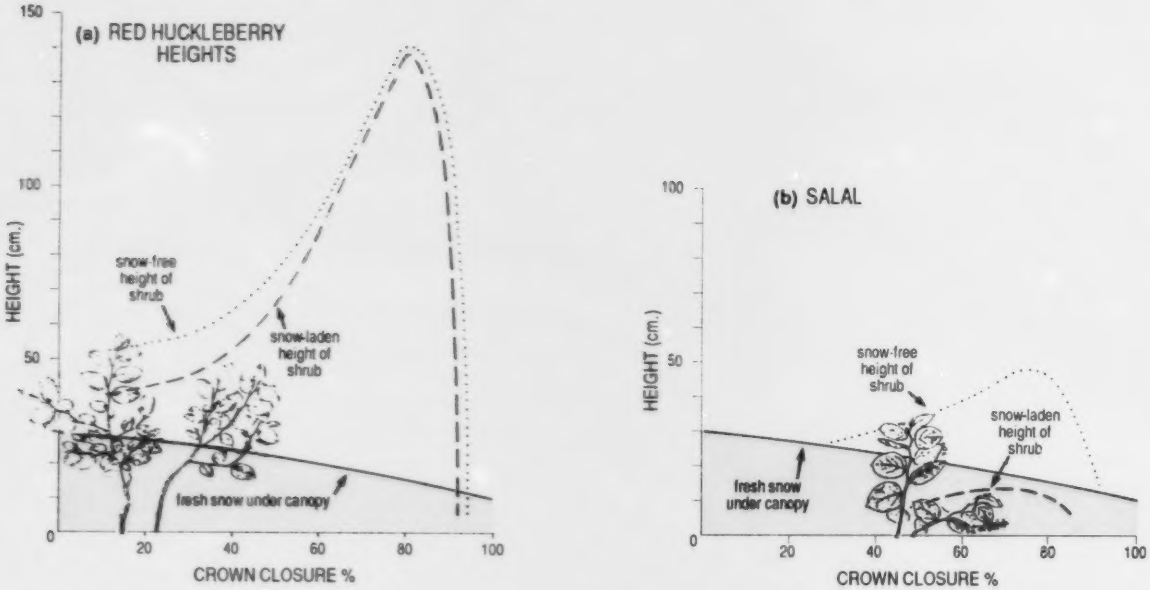


Figure 34. Red huckleberry (a) and salal (b) plants are tallest under moderately closed canopies, which also intercept significant amounts of snow. Broad-leaved salal is buried more quickly than is red huckleberry. The figure illustrates conditions for a 30-cm snowfall (data of McNay et al. *[1988] and F.L. Bunnell, F.W. Hovey, and D.J. Vales [unpublished]).*

Interspersion of Forage and Cover Areas

Because of the limited movements made by deer within their seasonal ranges, resources of food and cover need to be available close together to encourage heavy deer use. Open forests of all ages often provide both adequate security cover and abundant food in the same stand. In other cases, a single stand will provide either forage (e.g., in an open clearcut with a lush herbaceous community) or cover (e.g., in a dense young-growth stand with almost no understory vegetation), but not both. In the latter situation, good interspersion of food and cover patches is extremely important.

Interspersion of food and cover is one of the major factors determining habitat quality or suitability for deer. It influences the distribution of animals, their seasonal and annual movement patterns (see the next section), and the number produced per unit area. Generally, the more closely food and cover resources are intermixed, the greater the density of deer an area can support.

Based on the "edge-effect," which implies that most game species prefer to live near borders between different kinds of required habitat (Leopold 1933), management guidelines for deer habitat in many areas have emphasized the greater value of small openings compared to large ones (e.g., Thomas *et al.* 1979; Witmer *et al.* 1985). Kremsater (1989) used data from radio-tagged deer in the Nimpkish River valley and Nanaimo River areas (Harestad 1979; McNay and Doyle 1987) to evaluate deer use of habitat near borders. Her analyses indicate that deer tend to concentrate their use of clearcuts within 100 m of cover (Figure 35), and to make less use of areas beyond 100 m of cover than one would expect based on the amount of such areas available.

Thomas *et al.* (1979) hypothesized that deer prefer a secure core area of cover within which they are protected from disturbance by the surrounding stand. The hypothesis suggests that it is possible for the interspersion of stands to be too finely grained; the surrounding stand could be too small to provide protection from disturbance. The optimum amount of intermixing of stands or patches providing either cover or forage would then be limited by the need for patches of security cover to be wide enough to provide a secure core area. Kremsater's (1989) analyses of data from Vancouver Island showed that use of cover patches

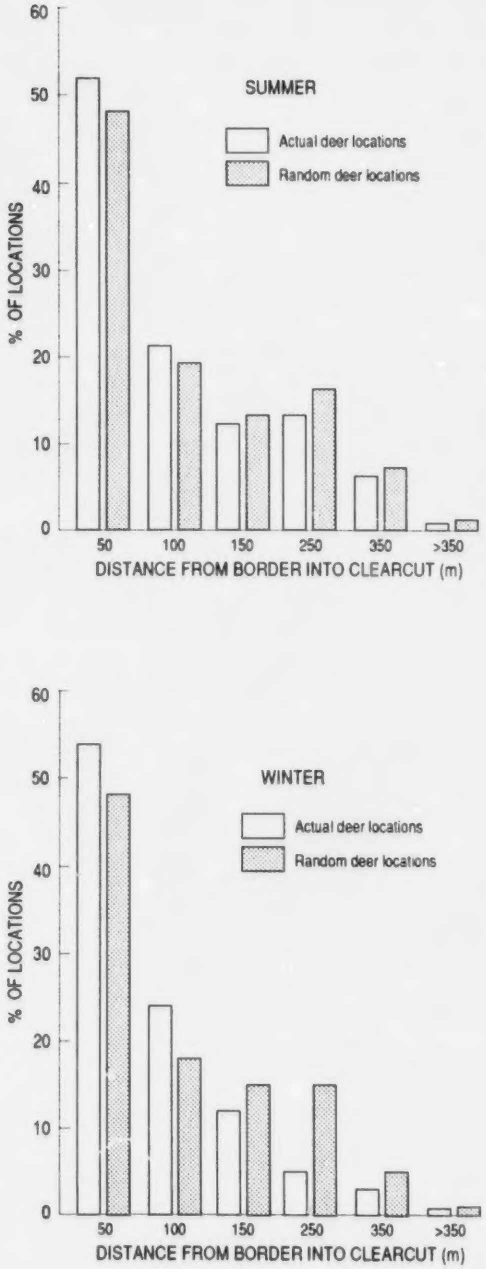


Figure 35. Distributions of radio-telemetry locations of deer in clearcuts relative to distance from cover in the Nanaimo River area, as compared to random locations throughout the study area. Adapted from Figure 17 of Kremsater (1989).

is highest within 200 m of their border (Figure 36), suggesting that cover patches up to 400 m wide will be used effectively. If there is a minimum width for effective cover patches, it was not apparent from Kremsater's analyses. Stands that provide both food and cover within a single area provide the ideal degree of interspersion because the distance from food to cover is close to zero throughout.

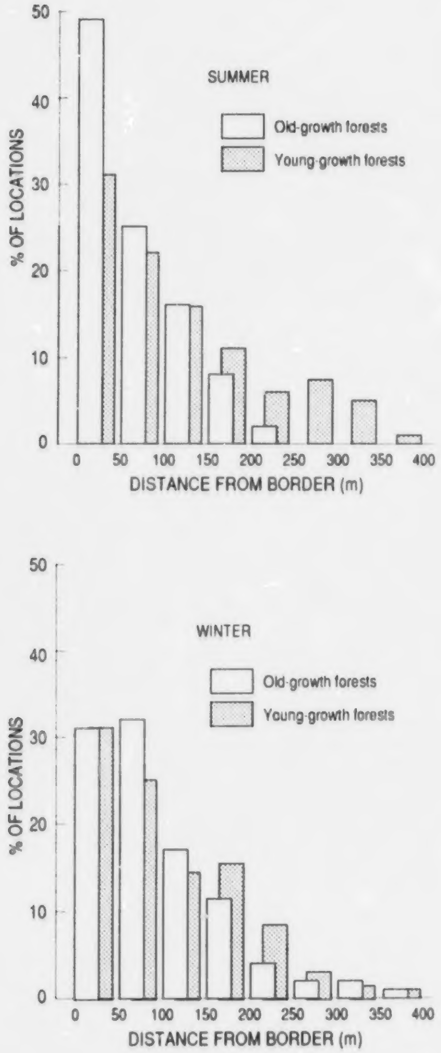


Figure 36. Distributions of radio-telemetry locations of deer in cover adjacent to clearcuts in the Nanaimo River area (unpublished IWIFR Program data, summarized by Kremsater 1989).

Because distance between food and cover is the key factor determining the intensity of deer use, the width of patches of habitat is more important than their size. Clearcuts that are less than 200 m wide throughout (i.e., less than 100 m to cover from any point) would provide for maximum deer use, regardless of whether the areas covered 4 ha or 100 ha. Openings up to 400 m wide would receive less, but still substantial, amounts of use in their central portions. The centres of openings more than 400 m wide would receive very little use unless topographic features provided some security cover.

MEETING THE REQUIREMENTS

Tactics of Habitat Selection

Given the interspersion of food, water, and cover in their environment, deer must select places to live that allow them to meet and balance these requirements. The set of tactics each deer uses to select habitats and obtain an appropriate set of requirements is related to three broad phenomena: home range, migration, and seasonal ranges. Within their seasonal ranges deer exhibit further selection, called microhabitat selection, by concentrating their use within smaller areas producing particularly favourable conditions.

All mammals have a home range, an area known intimately and travelled through regularly (Burt 1940). An animal's familiarity with its home range allows it to locate needed resources efficiently. Among the principles determining size of home range, the most important one affecting animals of about equal size is the density (abundance per unit area) of available resources. As this density decreases, animals must cover a larger area to attain their needs (Harestad and Bunnell 1979).

Similarly, if different requirements such as food and cover are widely separated or poorly interspersed, home ranges must be larger than where requirements are well interspersed (Figure 37). Where interspersion is particularly poor, such as where a large, recently logged clearcut provides abundant food but no security cover, some potential deer food and space will go unused. Poor interspersion of requirements can thus lower overall habitat quality.

Deer requirements differ between seasons (e.g., shelter from snow is needed only during winter) and deer may extend their home ranges to obtain the different requirements by either migrating or shifting locally as the seasons change. Migration consists of movement between seasonal ranges that are distinctly separated, often 2-5 km apart (McNay and Doyle 1987). Seasonal shifts involve changes in areas of use that are not widely separated and may even overlap (Figure 38). Where seasonal differences in habitat conditions are pronounced, as in the deep snowpack zone, requirements of deer are best met by different habitat types in each season. As well, the seasonal ranges are usually discrete. Where seasonal habitat differences are smaller, as in the shallow and moderate snowpack zones, seasonal ranges often overlap.

Because requirements always differ somewhat between seasons, the forestry practices that produce suitable deer habitat differ with the kind of seasonal range. For example, clearcuts with relatively small amounts of cover may provide useful summer range but very poor winter range.

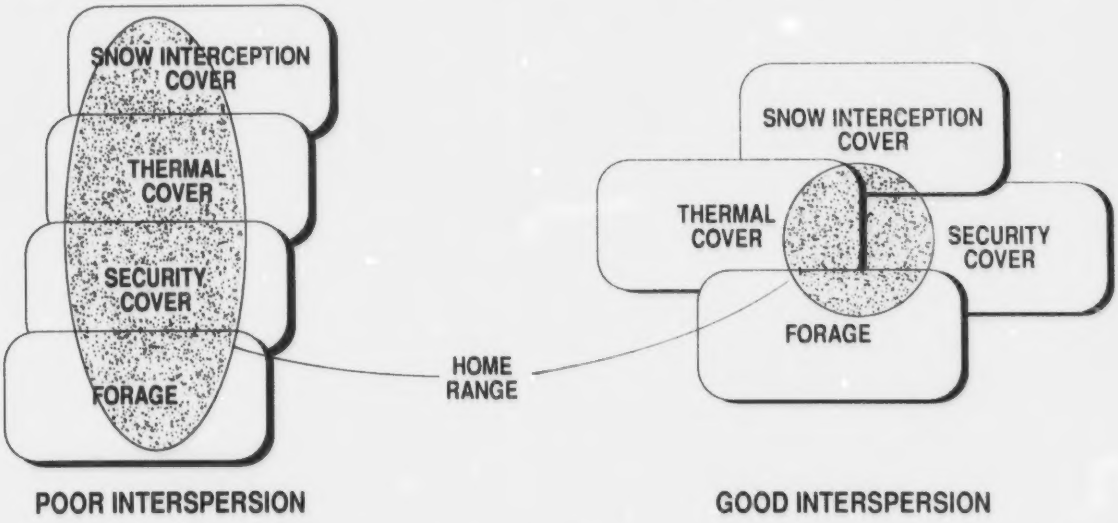


Figure 37. Home ranges of most deer are small when habitats are well interspersed because deer need to move only short distances to find all their habitat requirements.

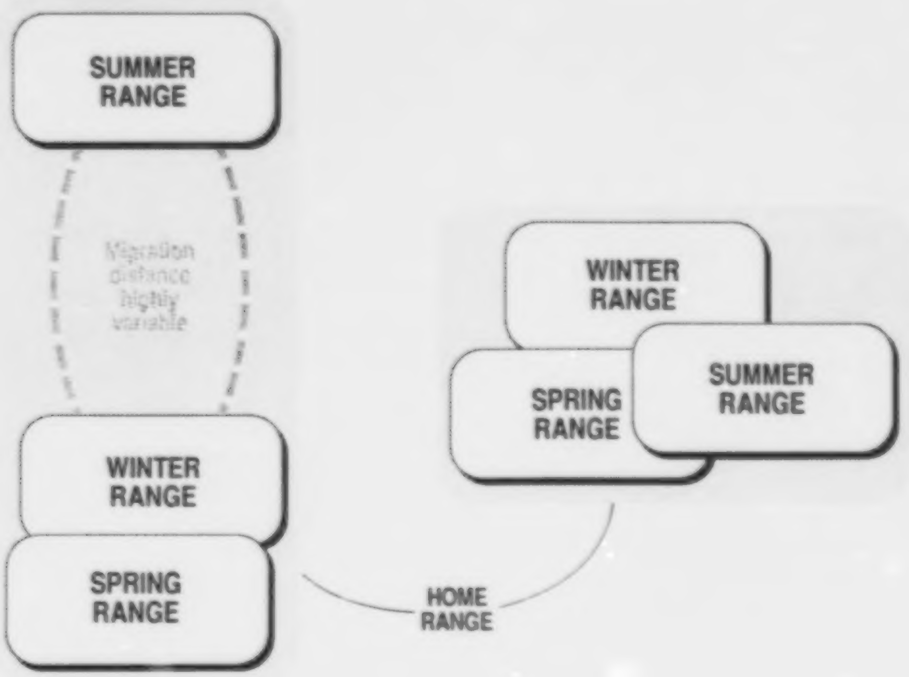


Figure 38. Seasonal movement distances are influenced by the distribution of seasonal ranges.

Migratory and Resident Deer

Because deer requirements are unequally distributed in their environment and each deer finds its own solution to obtaining requirements, home ranges vary considerably. There are, however, broad patterns of behaviour that have important implications to management. These patterns are associated with the density and predictability of deer requirements.

Generally, seasonal changes in home range occur when an animal receives a net benefit by moving. Animals are exposed to increased risks from predators when moving to or through less familiar areas and the net benefit gained by moving should be substantial before movement occurs. In some parts of North America, the interaction between weather and resources is sufficiently consistent from year to year that all or none of the deer migrate. In southwestern British Columbia, seasonal weather is so unpredictable that natural selection has fixed no single tactic within a population. Instead, populations contain both migratory and sedentary (resident) individuals (Harestad 1979; McNay and Doyle 1987). Broad differences do occur, however, between the shallow or moderate and deep snowpack zones. In the moderate snowpack zone, about 20-25% of the deer migrate between separate summer and winter ranges; in the deep snowpack zone, 70% or more of the deer migrate.

There is also evidence from studies of non-migrating deer that seasonal shifts in home range are related to seasonal changes in the relative abundance of their requirements (Harestad 1979). Animals extend or shift their ranges to obtain seasonally scarce requirements. Non-migrating or resident deer show similar sizes of summer home ranges, about 55 ha, in the moderate and deep snowpack zones. During winter, when specific requirements (e.g., food and cover) may be more scarce and scattered, deer in the deep zone range more widely (48 ha) than deer in the shallow zone (36 ha).[6]

Because deer are not strongly territorial and home ranges of different deer overlap, densities in favourable habitats can reach 20 deer per square kilometre year-round, and many times that when deep snows concentrate the animals on key winter ranges.

Microhabitat and Forage Selection

Deer do not use all areas of their home range equally. About 50% of a deer's time is spent in 5-10% of its home range (data of McNay and Doyle 1987). Unequal use of areas occurs because deer have favourite places and use some areas frequently that meet a requirement especially well. Favourite places include bedding sites which may be used daily for several weeks, and again next year when the season recurs. Other areas of intensive use may be local concentrations of forage or ideal cover during winter. McNay and Doyle (1987) reported that during cold and snowy periods the area used by deer decreased to <40% of the area used during mild winter periods. The selection of localized features, microhabitat selection, is to some extent predictable and related to forest cover (e.g., snow interception), but it is never completely predictable because deer appear to exert individual choices (e.g., bedding sites).

The same mixture of individual choice and predictability occurs during forage selection. Deer increase the energy potentially available to them by selecting food carefully. They use taste (Crawford and Church 1971), smell (Oh *et al.* 1968), and possibly texture, bite size, and sight to select plant species, individual plants within species, and specific plant parts. Part of this selection is readily understood because it includes preference for sucrose, which is highly digestible, and avoidance of volatile compounds, which inhibit rumen function. Part is poorly understood and usually termed "behaviour"; deer may repeatedly browse one plant, leaving adjacent individuals untouched. Within Douglas-fir some of this difference among individual plants may result from different chlorogenic acid concentrations (Radwan 1972, 1974), variable genetic resistance to browsing (Dimock 1974), or differences in microsite or nursery practices which produce more succulent, attractive plants.

Management Implications

If migratory deer are present, forest management activities will affect the population over a much larger area than would be the case with a population composed of resident animals only. For example, the average annual home range of migratory deer in the moderate snowpack zone is 1770 ha; or 12.6 times greater than annual ranges of resident deer in that zone (140 ha).[7] Migratory deer do not fully exploit the entire area of 1770 ha, but select specific microhabitats or areas within their home ranges that meet specific seasonal requirements. By exploiting ideal summer range, often at higher elevations well removed from favourable winter range, they generally grow larger and reproduce better. Forest management activities anywhere within the large area of their annual ranges may influence the migratory deer (Figure 39), whereas many residents occupying portions of the same area will remain unaffected.

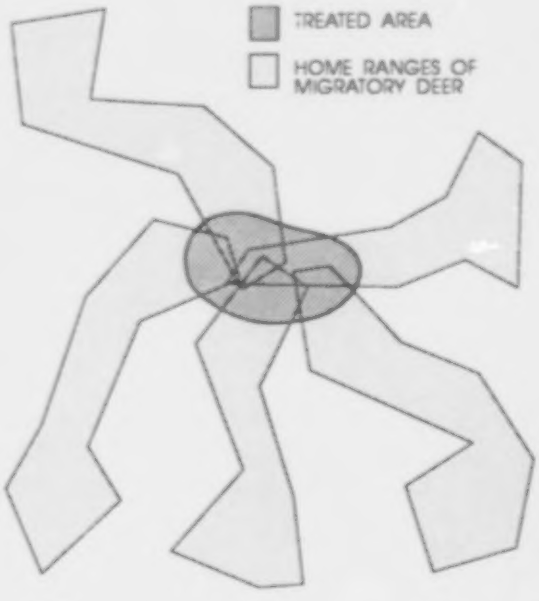


Figure 39. Migratory deer that range widely may be affected by forestry treatments that occur only on a small portion of their home ranges.

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[6] A.S. Harestad and IWIFR Program, unpubl. data.

[7] IWIFR Program, unpubl. data.

There is no evidence that an animal will change its behaviour once it has adopted either a migratory or sedentary pattern. Thus, destruction of winter range caused by logging, fire, or wind may have severe consequences because both resident and migratory animals are unlikely to explore unfamiliar but favourable areas even if these are only a few kilometres away.

Deer do, however, shift their use over time within their ranges to exploit changes in resource availability. This shift also has implications to forest management. When winter conditions are not severe and resources are well interspersed, female deer can meet their requirements within an area of 10-20 ha. When their requirements are more widely scattered, deer extend their home ranges and are less abundant or productive (Figure 40). The extension may be as little as a shift in areas of concentrated use with the seasons, or as much as a migration of several kilometres. The effects are obvious in the deep snowpack zone where female deer decrease the mean size of their range from 48 ha in winter to 25 ha in spring (Harestad 1979). In winter, specific kinds of cover are necessary to intercept snow and permit access to forage, so deer have to range more widely to obtain their requirements. Appropriate silviculture can place these kinds of cover closer together and permit greater abundance of deer.

Because climatic conditions are more favourable in the shallow and moderate snowpack zones, the overall potential for deer production is higher there than in other zones. Habitat management activities will thus pay off most — all other factors being equal — in the zones of least snowfall.

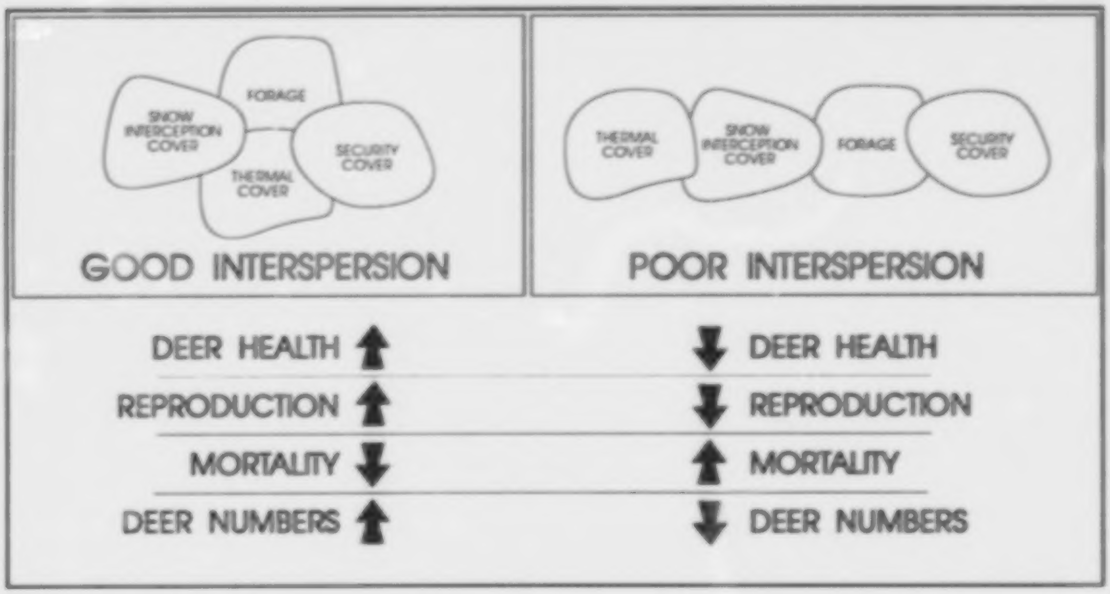
SNOW INTERCEPTION COVER
FORAGE
SECURITY COVER
THERMAL COVER
GOOD INTERSPERSION
THERMAL COVER
SNOW INTERCEPTION COVER
FORAGE
SECURITY COVER
POOR INTERSPERSION
DEER HEALTH
REPRODUCTION
MORTALITY
DEER NUMBERS
DEER HEALTH
REPRODUCTION
MORTALITY
DEER NUMBERS

Figure 40. Good habitat interspersion encourages healthier, more productive deer populations.

HABITAT NEEDS ON SEASONAL RANGES

Winter Range

Resources are most limited in all snowpack zones during the winter. Concentrations of protein and digestible energy in forage plants decline then to their lowest levels and fewer forage species are available to deer than in spring and summer. When snow falls, many of the most digestible forage plants, such as bunchberry and deer fern, are buried. Deciduous stands no longer provide adequate thermal cover because their leaves have fallen, and less sunlight is available for the animals to exploit in maintaining favourable temperatures. Pregnant deer are allocating energy, protein, and water to developing embryos. Adult male deer have eaten very little during the rut, but have spent considerable energy pursuing females. Both sexes are using fat reserves acquired during the summer and fall, and both sexes are losing weight.

As snow depth increases more food is buried, less energy is available to deer, and more energy is expended as deer sink into deeper snow. The influences of topography and the forest canopy on snow depth become increasingly important with progression inland from the shallow snowpack zone through the moderate and deep zones. Along this gradient, fewer and fewer areas can serve as winter range because energy availability falls too low and energy output for movement rises too high in most stands. The interspersion of resources becomes increasingly important because movement must be kept to a minimum in areas of deep snow.

In the very deep zone, snow becomes so deep during most winters that deer cannot survive, no matter how favourable the topographic and vegetative conditions might be. Because coastal weather is so variable, many winters bring long warm spells that leave the moderate and deep zones free of snow for days or weeks at a time. Conversely, deep snowpacks occasionally persist for two weeks or more even in the shallow zone. Deer may thus survive the winters nicely in all but the very deep zone for years in succession, only to be drastically reduced in number during a single severe winter that strikes all zones. The following discussion of winter habitats in the four zones reflects the relative influence of severe winters on deer populations in each.

Shallow snowpack zone

Climatic and topographic factors are least limiting in the shallow snowpack zone. A few snowfalls do occur in most winters, but the snowpack remains shallow and melts relatively quickly. As a result, deer can meet their needs for forage and cover in many stand types. Clearcuts up to about 15 years of age provide abundant rooted forage, and smaller but still sufficient amounts of food are available in most open (<70% canopy closure) young- and old-growth forests. Security cover can be found in patches of dense young conifers at least 2 m tall; in stands of taller trees with dense trunks, lower branches, or understory vegetation (or all three); and even in patches of tall evergreen shrubs, such as salal, or dense deciduous vegetation, such as is often found in riparian and roadside strips. Most forests greater than 10 m tall with dense canopies (≥70% closed) overhead can serve as thermal cover during periods of cold weather. Clearcuts, rock outcrops, and other openings permit deer to warm themselves in direct sunlight on clear days.

A wide variety of forest conditions therefore provides suitable winter habitat in this zone. Security cover and forage are the key concerns. These can be found in sufficiently close proximity under two conditions:

1. heterogeneous forests that provide a mixture of open and closed canopies within stands; and
2. areas with interspersed clearcut and forested patches that provide, in different stands, forage and cover that are never more than about 200 m apart (Figure 41). All aspects and slope positions are used by deer during winter in the shallow snowpack zone.

Moderate and deep snowpack zones

In times of little or no snow, deer living in the moderate and deep snowpack zones can be found using the same variety of habitats as those in the shallow zone. After several successive mild winters, some deer will be resident year-round in patchy young stands and in areas with mosaics of clearcut and cover (McNay and Doyle 1987). Others will spend all or part of the winter in old growth.

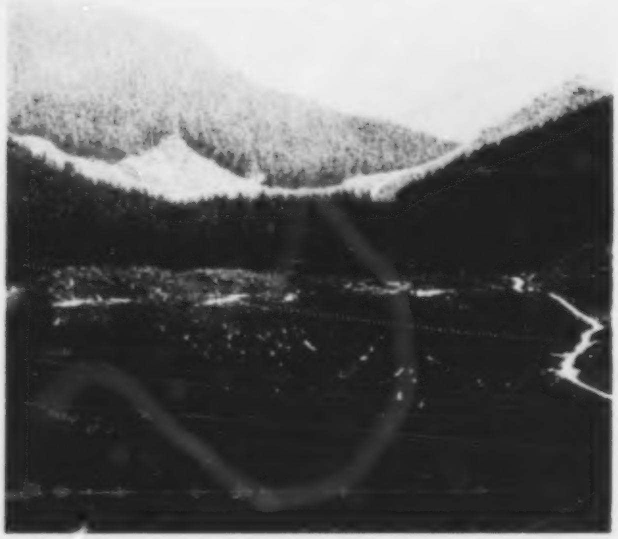

Figure 41. Small clearcuts interspersed with forested patches provide good winter habitat in the shallow snowpack zone.

Snowy winters, however, occur relatively frequently in the moderate zone, and still more often in the deep snowpack zone. Under the stressful conditions imposed by deep snow, only a narrow range of habitats can sustain large numbers of deer. These are called "critical winter ranges" because of their importance in maintaining local deer populations. As deep snowpacks accumulate, many deer move out of young forests and areas where the distance between food and cover requires the deer to make movements. Those that remain in such places perish if the snow persists for most of the winter.

The deer most likely to survive periods of deep snow are those that live where features of topography, stand structure, and stand age combine to produce shallow snow, abundant forage, and mild operative temperatures in the same habitat. Appropriate topography is important because it influences the depth and distribution of the snowpack. Stand structure is important because it influences snow depth and amounts and interspersion of deer requirements, including forage, security cover, and thermal cover. Stand age is important because it seems to be one of the major factors that determine arboreal lichen abundance and litterfall rate (Stevenson 1985).

Critical topographic features for good deer survival (critical winter ranges) are:

- southerly aspects;
- moderate to steep slopes (40-100%); and
- low elevations (<1000 m).

Small rocky outcrops or bluffs are beneficial, but not necessary. These topographic features help to reduce the depth of the snowpack because they provide relatively intense solar radiation and warm temperatures, particularly around bluffs where snow is melted by back radiation and swept away by wind. Other aspects and slopes provide lesser but still significant values as winter range sites. Critical features of stand structure (Figure 42) are:

- long, well-developed crowns which intercept snow efficiently, thereby reducing rates of food burial and costs of movement;
- small openings in a variable canopy that averages 65-70% closed overall, which together permit growth of key forage species, interception of substantial amounts of snow, and provision of overhead thermal cover (thus good interspersion); and
- multiple canopy layers with an understory of shade-tolerant conifers which provide additional thermal cover, security cover, and — if western redcedar or Douglas-fir are present — food (thus good interspersion).

The stand age for significant arboreal lichen production is usually beyond 100 years (Bunnell and Eastman 1976).

These structural features are best provided naturally by heterogeneous old-growth stands. Estimates from Vancouver Island indicate that winter densities can exceed 100 deer per square kilometre in old-growth forests that provide both food and cover (Hebert 1979). Special silvicultural regimes may allow creation of winter range in managed stands, but such stands will have to mimic closely the key features of old-growth stand structure (Nyberg *et al.* 1986). In the deep snowpack zone such efforts will be less likely to succeed than in the moderate zone, because of the heavier and more frequent snowfalls.

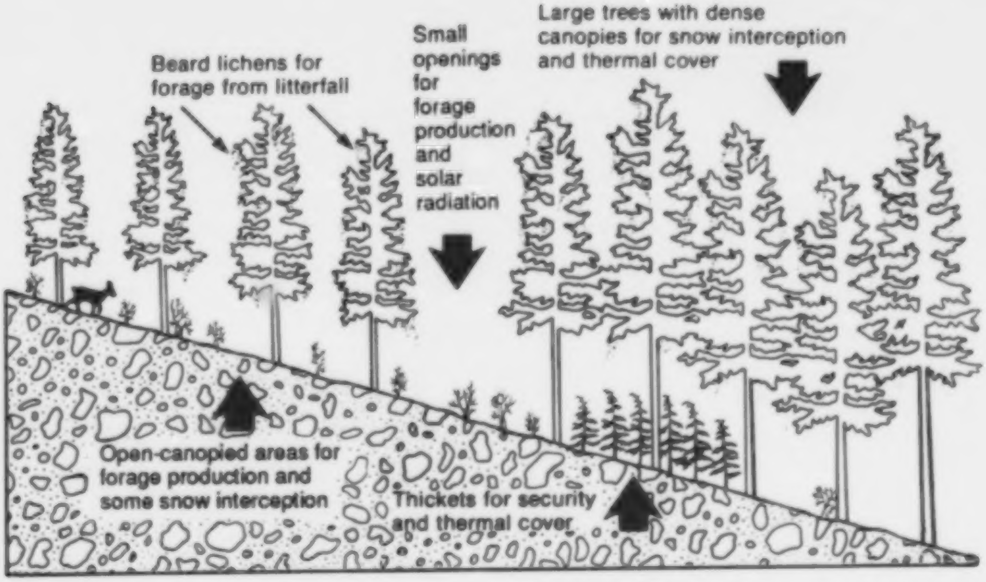
Beard lichens for forage from litterfall
Small openings for forage production and solar radiation
Large trees with dense canopies for snow interception and thermal cover
Open-canopied areas for forage production and some snow interception
Thickets for security and thermal cover

Figure 42. Suitable stand characteristics are key components of critical winter ranges for deer.

Very deep snowpack zone

During the mildest periods of the mildest winters, portions of the very deep zone will be inhabited by deer. Rarely, there may even be winters in which the lowest portions of this zone remain almost snow-free. Some deer regularly stay as high on the mountains as snow will allow, perhaps to avoid predators. Those animals may exploit the very deep zone as winter habitat whenever snow conditions allow. For most of the population, though, this zone is unusable as winter habitat most of the time (Figure 43). It contributes so little to wintering deer in most years that it is of no concern to habitat managers as winter range.

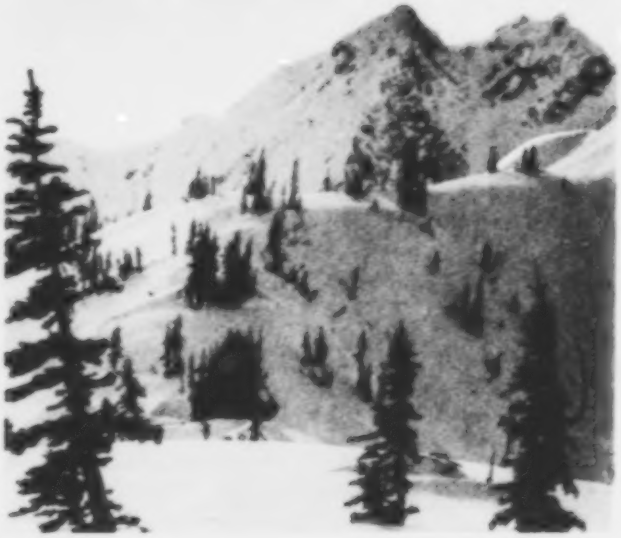

Figure 43. Areas above 1000 m are unsuitable as winter range for deer.

Spring Range

At the onset of spring, deer are often in the poorest condition they will experience all year. Throughout the winter, when forage of only poor quality was available, they drew on their energy and fat reserves to survive. Come spring, pregnant females enter the last term of gestation and the nutritional demands of the embryos increase dramatically. Survival of the developing fawns will be closely related to their birth weight, which depends largely on their mothers' nutritional status (Bunnell 1987). For adults to recover lost weight and produce large numbers of healthy fawns, they must find abundant, high-quality forage. Food is thus the most critical component of spring ranges.

In the very deep snowpack zone, persistent snowpacks prevent early spring use in most years. Everywhere else, the most important feature of spring ranges is their ability to produce large quantities of tender, young plant material early in the growing season. Both the early reduction of winter snowpacks to expose forage plants and early initiation of growth are important. These two phenomena are favoured by sites that share many of the topographic characteristics of winter ranges in the moderate and deep zones: low elevations (<800 m), southerly aspects, and moderate to steep (40-100%) slopes. Good spring range sites sometimes extend onto lower, gentler slopes where rich, moist soils produce more herbs than are found on most winter ranges. In the shallow zone, other sites can also serve as valuable spring range because rapid snowmelt is seldom a concern. The relative importance of topography in determining the suitability of sites increases in the moderate zone and becomes extremely important in the deep zone.

Rich communities of herbs, ferns, and shrubs make the best spring ranges. A small number of understory types supports such communities (Figure 44), and deer can be expected to make heavy use of those types if overstory conditions are appropriate. Furthermore, burned clearcut sites often support abundant herbs — especially fireweed — regardless of understory type. Like many herbs, new growth of fireweed is high in protein and digestibility. Open areas such as clearcuts and rock outcrops, and open forests such as deciduous and widely spaced coniferous stands, provide the most rapid snow melt and initiation of spring growth.

Security cover is needed near spring foraging areas, and thermal cover may be important to allow deer to find shade on warm days and shelter from rain on cold days (Parker 1988). In all zones, then, the best spring ranges are south slopes with small openings (especially burned clearcuts) surrounded by forests that serve as security and thermal cover.

Biogeoclimatic Units	S N R[1]	Soil Moisture Regime (Potential Hygrotope)[2]							
		0	1	2	3	4	5	6	7
CDFa[3] (CDFmm[4])	A B C D E	Lichen - Moss	California Brome		Salal - Huckleberry		Moss		Sphagnum - Hardhack
			Ocean-spray - Tall Oregon-grape		Salal - Dull Oregon-grape		Sword Fern		Skunk Cabbage
CDFb (CWHxm1)	A B C D E	Lichen - Salal		Salal - Huckleberry			Moss		Sphagnum - Hardhack
		Ocean-spray - Tall Oregon-grape		Salal - Dull Oregon-grape			Sword Fern / Salmonberry[5]		Skunk Cabbage
CWHa1 (CWHxm2)	A B C D E	Lichen - Salal	Salal - Huckleberry		Huckleberry - Moss		Deer Fern		Sphagnum - Hardhack
			Moss - Dull Oregon-grape				Sword Fern / Salmonberry[5]		Skunk Cabbage
CWHa2 (CWHdm)	A B C D E	Lichen - Prince's Pine	Salal - Huckleberry		Huckleberry - Moss		Deer Fern		Sphagnum - Hardhack
			Moss - Dull Oregon-grape				Sword Fern / Salmonberry[5]		Skunk Cabbage
CWHb1 (CWHvm1)	A B C D E	Lichen - Salal	Salal - Huckleberry		Huckleberry - Moss		Deer Fern		Sphagnum - Deer Fern
					Moss		Sword Fern / Salmonberry[5]		Skunk Cabbage
CWHb2 (CWHvm2)	A B C D E	Lichen - Moss	Moss	Huckleberry - Moss		Deer Fern		Sphagnum - Deer Fern	
						Rosy Twistedstalk - Five-leaved Bramble		Skunk Cabbage	
CWHb3 (CWHmm1)	A B C D E	Lichen - Salal	Salal - Huckleberry		Huckleberry - Moss		Deer Fern		Sphagnum - Deer Fern
			Salal - Dull Oregon-grape		Moss		Sword Fern / Salmonberry[5]		Skunk Cabbage
CWHb4 (CWHmm2)	A B C D E	Lichen - Moss	Huckleberry - Moss				Deer Fern		Sphagnum - Deer Fern
			Huckleberry - Dull Oregon-grape				Rosy Twistedstalk - Five-leaved Bramble		Skunk Cabbage
CWHb5 (CWHms1)	A B C D E	Lichen - Falsebox	Moss - Kinnikinnick		Huckleberry - Moss		Deer Fern		Sphagnum - Deer Fern
					Huckleberry - Rosy Twistedstalk		Oak Fern		Skunk Cabbage
CWHc1 (CWHds1)	A B C D E	Lichen - Prince's Pine		Moss - Falsebox			Moss		Sphagnum
		Ocean Spray - Tall Oregon-grape		Moss - Dull Oregon-grape			Oak Fern		Skunk Cabbage
CWHd1 (CWHvh1)	A B C D E	Lichen - Salal	Salal - Huckleberry			Deer Fern			Sphagnum
				Moss		Sword Fern			Skunk Cabbage
MHa	A B C D E	Lichen - Pink Mountain-heather	Huckleberry - Moss			Deer Fern		Sphagnum - Deer Fern	
				Huckleberry - Rosy Twistedstalk		Rosy Twistedstalk - Five-leaved Bramble		Skunk Cabbage	
MHb	A B C D E	Lichen - Pink Mountain-heather	Black Huckleberry - White-flowered Rhododendron		Huckleberry - Moss		Deer Fern		Sphagnum - Deer Fern
					Huckleberry - Rosy Twistedstalk		Rosy Twistedstalk - Five-leaved Bramble		Indian Hellebore
MHp	A B C D E	Lichen - Pink Mountain-heather	Mountain-heathers		Black Huckleberry - White-flowered Rhododendron		Sitka Valerian - Arnica		Indian Hellebore

1. Soil nutrient regime: A = very poor, B = poor, C = medium, D = rich, E = very rich
2. Soil moisture regime (Potential hygrotope): 0 = very xeric, 1 = xeric, 2 = subxeric, 3 = submesic, 4 = mesic, 5 = subhygric, 6 = hygric, 7 = subhydric
3. Codes for biogeoclimatic units from Green *et al* (1984).
4. Revised codes for biogeoclimatic units 1988 (D. Meidinger, personal communication).
5. The Salmonberry (Devil's Club) type replaces the Sword Fern type on sites with a high water table.

☐ winter ☐ spring and summer ☐ spring

Figure 44. The highlighted understory types have the highest potential for producing forage for deer.

Summer Range

During summer and early fall, deer feed on abundant forage of moderate to high quality. After first regaining the weight lost over winter, males develop antlers and accumulate fat reserves they will draw on during the fall rut and the subsequent winter. Females add fat while also, in most cases, expending large amounts of energy in providing milk to their nursing fawns. Clearcuts, open forests, and natural openings such as subalpine meadows provide large amounts of preferred food. Due to delayed phenology, high forage quality is maintained late in the growing season by plants on cool sites, especially at high-elevations. Migratory deer that move to alpine and subalpine areas as the season progresses are able to profit from the higher quality forage found there during late summer and fall. These animals typically attain greater adult weights than deer that remain at low elevations. The very deep snowpack zone is thus important to deer wherever lush alpine and subalpine forage is available.

Forbs such as fireweed and shrubs such as *Vaccinium* and *Rubus* species are key summer food items. Many other plants, including conifer foliage and ferns, are also readily eaten. With the coming of fall, deer eat the highly digestible berries of salal, *Vaccinium*, and *Rubus*.

Of the deer that winter in the shallow and moderate snowpack zones, 80% or more may summer at forested elevations.[8] In the deep snowpack zone where a greater proportion of the deer are migratory, forestry practices may affect the summer range of less than half the deer that would be present during winter. During summer the others will be in the very deep zone at elevations above productive forest land.

At forested elevations, clearcuts are often used heavily for foraging. Burned clearcuts are especially favoured because burning encourages fireweed, which is highly digestible and avidly sought.

As in other seasons, security cover is important and most deer remain within 200 m of such cover. Security is especially important during fawning in June. Because fawns have usually been born by the time migratory deer move to subalpine ranges, however, there is less need for security cover at high than at low elevations.

Often, during summer, deer use topographic features as security cover. These may be dips or swales that hide deer or, in some cases, bluffs or ridges that give an unimpeded view of large expanses of surrounding terrain. Deciduous vegetation provides additional security cover during summer.

Because high-elevation areas are often cool and windy, there is little need for summer thermal cover there. At lower elevations some cover from direct sun is necessary (Bunnell *et al.* 1985b), but it can be provided by a variety of vegetation types or topographic features.

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[8] IWIFR Program, unpubl. data.

SPATIAL PATTERNS OF HABITATS

Within a seasonal range the interspersion of required habitat components (e.g., food and security cover) affects deer density and productivity. If the required components are never far from each other, individual animals will be able to establish smaller home ranges and the area will usually support a larger population. If individual stands are managed to meet separate requirements, small stands of different structure that are closely juxtaposed (side by side) can provide adequately interspersed requirements. Seasonal ranges may also be closely juxtaposed, as is often the case with spring and winter ranges, or far apart, as is the case for summer and winter ranges of migratory deer.

Before forestry practices became widespread, black-tailed deer were adapted to natural patterns of habitat juxtaposition and interspersion. These patterns most often would have consisted of small openings (seepage sites, avalanche tracks, natural burns, and rock outcrops) interspersed among old-growth forest. In most old-growth forests, cover and food are finely interspersed. Large openings, such as alpine meadows, would have been used only by migratory deer as summer range.

A major impact of timber management has been to increase the size of openings and reduce the degree of habitat interspersion. In many instances, particularly where logging left dense brush and patches of residual trees that provided security cover, the creation of larger openings benefited deer during spring and summer by providing better forage. These large openings, however, were of no benefit as winter range in areas of deep snow.

In most cases, forestry practices have more impact on the interspersion of requirements within seasonal ranges than on the juxtaposition of seasonal ranges. In the shallow snowpack zone, winter, spring, and summer seasonal ranges may be closely juxtaposed and for some deer will overlap. In other zones such overlap is less likely, primarily because openings such as clearcuts, which provide spring and summer forage, cannot provide winter forage when plants are buried by snow. In the moderate and deep snowpack zones, more deer migrate and have their summer ranges well removed from spring and winter ranges. Furthermore, the effect of snow narrows the range of habitat types suitable as winter and spring range. Both winter and spring ranges are largely restricted to topography that acts to reduce the snowpack (e.g., low elevation and southerly aspects), but the structure of favourable vegetation differs. Cover and food requirements on winter range must be tightly interspersed because movement through snow is costly. As a result, the heterogeneous canopy of old-growth forest provides the best range. On spring range, openings that encourage rapid snow melt and early plant growth are critical. Requirements can be less well interspersed than on winter range.

SUMMARY OF IMPORTANT HABITAT FEATURES

The most important or most critical habitat features differ with the seasons. Generally, the number of critical habitat features decreases as seasonal weather conditions become less severe. The most important features are:

1. Winter range, moderate and deep snowpack zones:
    - topographic features that reduce snowpacks
    - tall, large-crowned conifers with 65-70% average canopy closure
    - arboreal lichens
    - tall shrub understory
    - small openings (less than one tree-height across) in the forest
    - cedar-hemlock thickets
    - tightly interspersed deer requirements
2. Winter range, shallow snowpack zone:
    - topographic features that reduce snowpacks important, but less critical
    - patches of cover, ideally with shrub understory
    - small clearcut or burned openings (less than 400 m across)
    - deer requirements less tightly interspersed
3. Spring range:
    - topographic features that reduce snowpacks and encourage early melt
    - openings that encourage early growth of herbaceous forage
    - cover near forage (i.e., within 200 m)
4. Summer range:
    - abundant forage, especially herbs and shrubs
    - patches of cover interspersed among food

Chapter 3
Ecology of Roosevelt Elk

by
K.R. Brunt

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INTRODUCTION

This chapter introduces the ecology of Roosevelt elk, including their habitat requirements in coastal forests and the ways in which they satisfy those requirements. Their distribution and life cycle are also covered briefly. The main focus of the chapter is the manner in which elk requirements are met in different seasons and snowpack zones.

While weather, predation, disease, and killing by humans can strongly influence elk populations, habitat quality is the most important long-term factor affecting elk distribution and abundance in coastal areas. Habitat quality is determined by both the nature of the physical components of habitat that satisfy elk requirements for food, cover, and water, and by the arrangement of these components across the landscape.

DISTRIBUTION

Two subspecies of elk occur in British Columbia: Roosevelt elk (*Cervus elaphus roosevelti*) and Rocky Mountain elk (*C. e. nelsoni*). Rocky Mountain elk are the more abundant and widespread subspecies, occurring in greatest numbers in the Rocky Mountains and the Rocky Mountain Trench of southeastern British Columbia (Figure 45). Roosevelt elk occur in Canada only on Vancouver Island, which is the northernmost limit of their natural distribution; in valleys at the head of a few mainland inlets adjacent to northern Vancouver Island; and on the Sechelt Peninsula as a result of several transplants in the late 1980's. They also occupy coastal forests west of the Cascade Mountains from northern California to the Olympic Peninsula of Washington State, and on Afognak Island in Alaska where they were introduced. Throughout the rest of this book, the term "elk" refers specifically to Roosevelt elk unless otherwise indicated.

Historically, elk were more widely distributed in coastal British Columbia than they are now (Cowan and Guiguet 1965). Human settlement and excessive hunting pressure, particularly on the lower mainland and southern Vancouver Island, led to local exterminations. The current limited distribution of elk on Vancouver Island results from a number of factors, including habitat quality, historical hunting and predation pressures, geographical barriers to colonization, transplant efforts, and a certain amount of chance in patterns of dispersal. Although they are now abundant in some areas of Vancouver Island (Figure 46), Roosevelt elk are considered to be well below their maximum sustainable population level.

Elk may be found in coniferous forests of all ages, as well as in deciduous stands and non-forested habitats such as wetlands, vegetated slides, and rock outcrops. Compared to deer, elk use alpine areas very little. Elk prefer wet areas such as wetlands, meadows, estuaries, seepage sites, and riparian areas adjacent to streams and in alluvial floodplains of major river valleys. The moist, rich soils which typically occur in these areas provide abundant sources of preferred forage species.

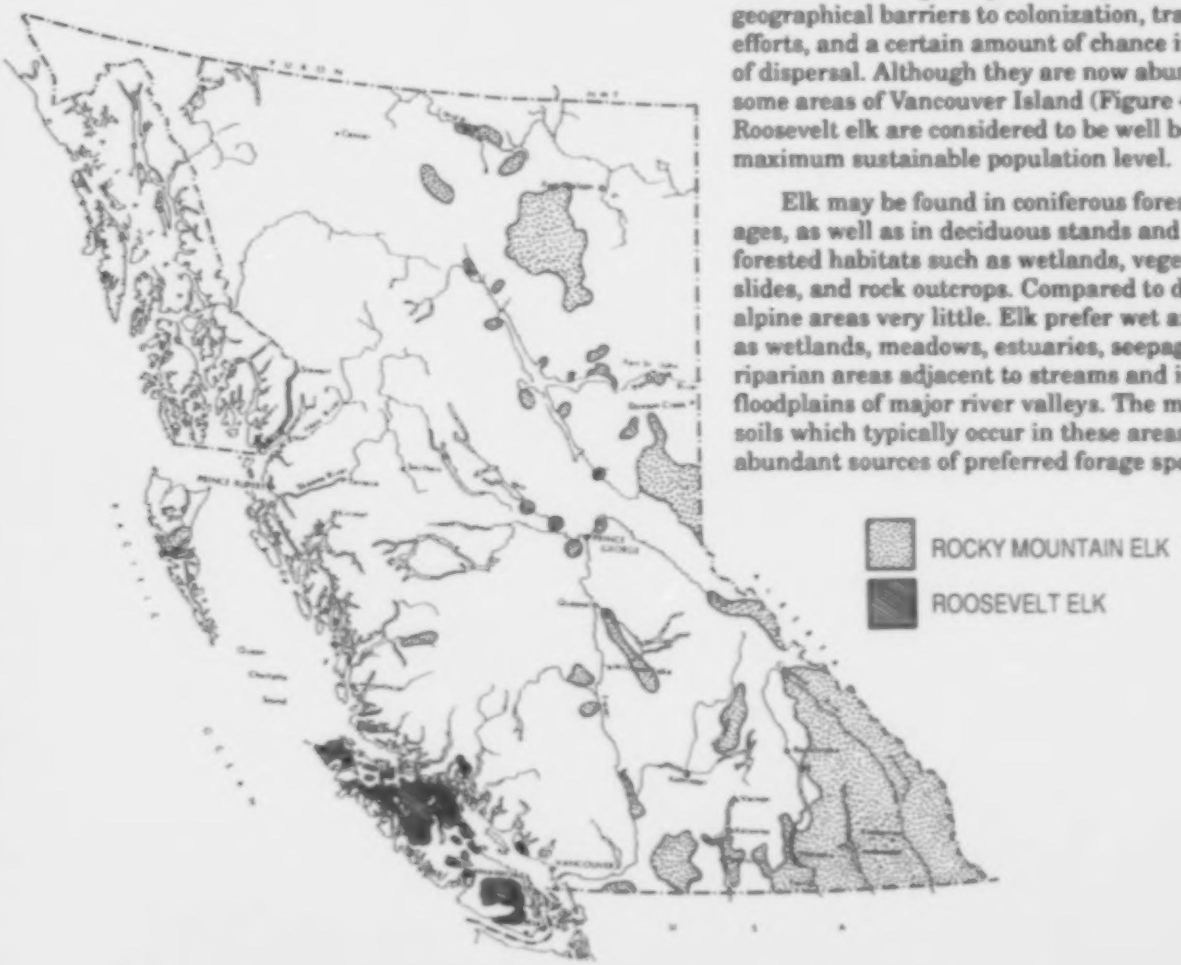

Figure 45. Current distribution of elk in British Columbia (modified from British Columbia Ministry of Environment, 1979).

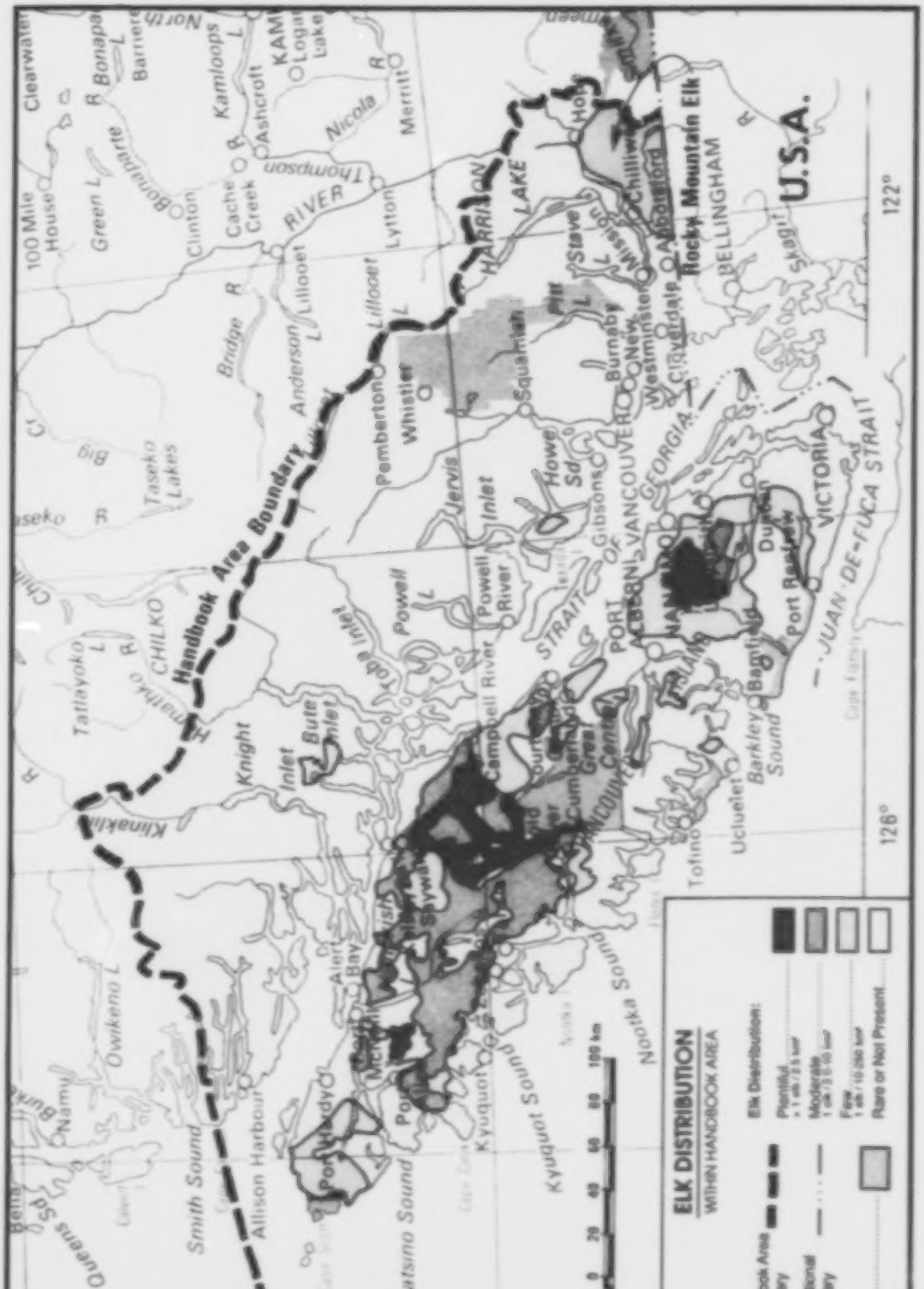
ELK DISTRIBUTION
WITHIN HANDBOOK AREA
Handbook Area Boundary
International Boundary
Parks
Elk Distribution:
Plentiful
Moderate
Few
Rare or Not Present
Handbook Area Boundary
Rocky Mountain Elk
U.S.A.
126°
122°
VICTORIA
VANCOUVER
BELLINGHAM
JUAN-DE-FUCA STRAIT
STRAIT OF GEORGIA
Port Hardy
Campbell River
Powell River
Nanaimo
Port Alberni
Tofino
Ucluelet
Whistler
Pemberton
Squamish
Lillooet
Kamloops
Smith Sound
Quatsino Sound
Kyuquot Sound
Nootka Sound
Barkley Sound
Knight Inlet
Bute Inlet
Harrison Lake
Chilliwack
Abbotsford

Figure 46. Current and estimated historical distribution of Roosevelt elk in British Columbia.

DESCRIPTION

Roosevelt elk are larger than their Rocky Mountain counterparts, with adult females averaging about 260 kg and adult males occasionally exceeding 400 kg. A trait of the Roosevelt subspecies is the terminal cup or slight palmation often seen on antlers of large bulls. Their antlers are usually shorter, heavier, and less symmetrical than those of Rocky Mountain elk. Like most members of the deer family, only male elk possess antlers. Yearling males (1-year-old) are known as spike bulls. They usually carry a set of long, single-point antlers which are replaced in the subsequent year with a set of uneven, branched antlers with three or four points on each side. The frequently broken tines and ragged appearance of antlers on 2-year-old bulls have given rise to the common term, "raghorn." In their fourth year, bulls are fully mature and thereafter usually carry antlers with five or more points on each side (Figure 47).

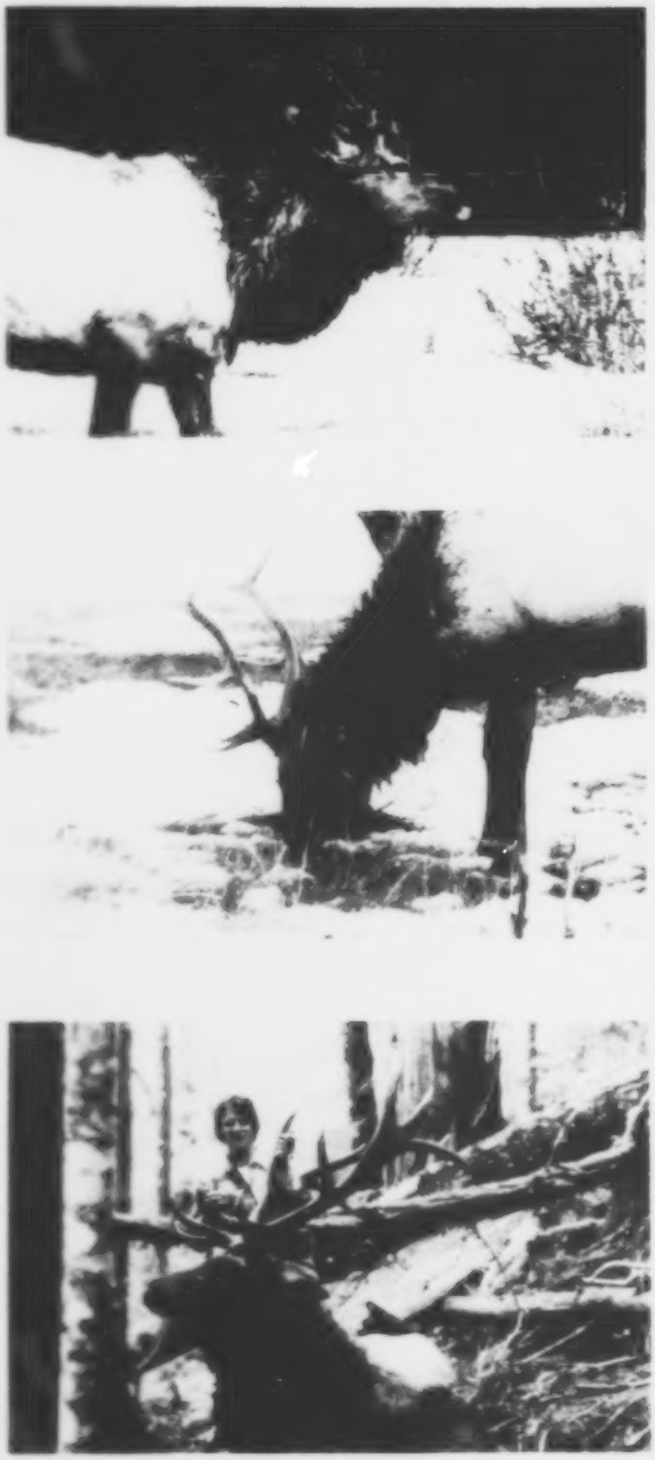

Figure 47. Typical antler development of spike (1-year-old), raghorn (2-year-old), and fully mature elk bulls.

SOCIAL BEHAVIOUR

Unlike deer, elk are highly social animals, usually banding together into groups of adult and yearling cows, calves (young less than 1 year old), and yearling (spike) bulls (Figure 48). More than 100 individuals may congregate in such a group. Groups of elk are dynamic, frequently forming temporary aggregations and then breaking into smaller groups again. These groups, or bands, are sometimes referred to as a herd. However, for management purposes, a herd is considered as all groups occupying the same general area such as a watershed. Herds are the basic unit of elk management activities.

Branch-antlered bulls generally remain apart from cow-calf groups, often forming small bachelor groups of similar-aged individuals, except during the breeding season or "rut" in September and October. During the rut, mature bulls defend a harem group of up to 30 cows for exclusive breeding rights. Spike bulls, though sexually mature, are usually excluded from breeding by the larger, dominant, branch-antlered bulls. Antler size is a key factor determining a bull's status and breeding privileges. Bulls frequently "bugle" during the rut to challenge rivals by emitting a series of grunts and high-pitched squeals. When bulls are relatively equal in size, antlers are used in a pushing match to establish which is the stronger. Injuries and (though rarely) even death can occur during these sparring matches, so physical combat is usually avoided in favour of visual displays to determine dominance.

Most dispersal from established herds is by sexually mature but subordinate males who leave to find areas where forage quality may be greater (Geist 1982), or where competition with mature bulls for breeding opportunities may be less severe. Mature cows may disperse to form new herds when elk density exceeds the carrying capacity of an area as a result of population expansion or a reduction in habitat quality.

Figure 48. Elk often form large groups of cows, calves, and immature bulls.

Hunting and predation are important sources of mortality affecting elk. There was no elk hunting season on Vancouver Island from 1970 through 1976, but since 1977, elk hunting has been allowed under a tightly controlled limited entry hunt (LEH) draw system. The LEH system allows specific harvest rates to be applied to each hunted population. Harvest is concentrated on the male segment of the population, but some females are also hunted. The kill is maintained at a conservative level which allows hunters to enjoy a high level of success yet still retains an abundant supply of adult bulls for breeding purposes. Approximately 60% of hunters drawing a bull permit are successful, while those obtaining an antlerless permit are successful about 70% of the time (Figure 50). The demand for opportunities to hunt elk is great; 7560 applications were received for 239 elk permits in 1988. The number of applications has continued to rise each year.

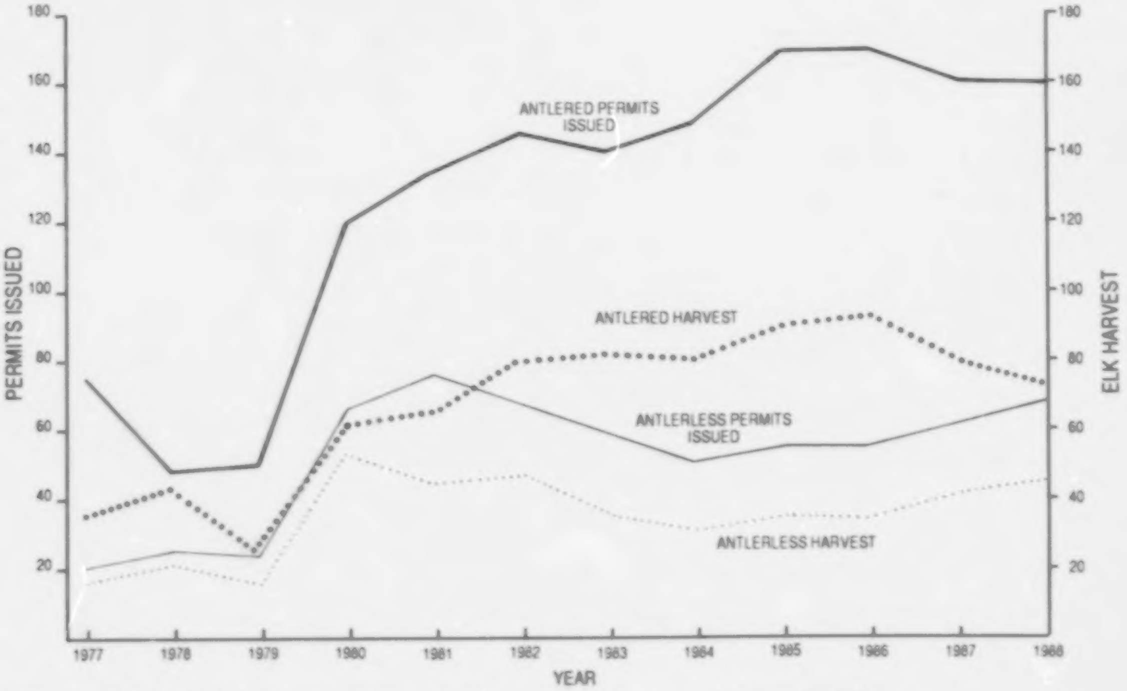

Figure 50. Trends in limited entry hunt permits and elk harvests on Vancouver Island, 1977-1988.

While the legal harvest is well controlled, illegal killing of elk is a major concern. Known poaching losses can approach 50% of the legal harvest, and the total illegal kill may be greater than the legal harvest (Janz and Becker 1986).

Wolves, black bears, and cougars are the major natural predators of elk on Vancouver Island. Calves are most often taken because they are more easily captured than adults. Wolves currently account for most of the predation on elk. After a period of wolf scarcity on Vancouver Island during the 1950's and 1960's, wolves increased dramatically during the mid-1970's, particularly on the north Island. This was the result either of expansion of relict populations or of an influx of wolves from the coastal mainland (Janz 1989). Feeding heavily on the abundant supply of deer, wolves rapidly increased in numbers and spread throughout Vancouver Island. Deer remain the major prey of wolves, but when deer densities decline, wolves may switch to other prey, including elk. Predation can strongly affect elk population levels (Janz and Hatter 1986), particularly on poor ranges where elk condition is low. Wolf management is thus a major concern on Vancouver Island, and wolf control programs may be necessary in areas of high wolf density.

Elk are hosts to a number of parasites including ticks, tapeworms, lungworms, and liver flukes, none of which appear to reduce the ability of healthy animals to survive and reproduce (Blood and Smith 1987). However, the ability of elk to

LIFE HISTORY

Large mature bulls shed their antlers in early spring, while younger males may carry their antlers until early summer. Immediately after their antlers have been shed, a new and usually larger pair begins growing. Antlers are among the fastest growing of animal tissues and abundant, high-quality summer forage is necessary for maximum potential development (Bubenik 1982). Antlers stop growing by late summer or early fall. They then harden and the outer skin, or velvet, is shed to expose the bony antler.

Cow elk generally conceive for the first time in their third year. Although elk in very good physical condition may breed at 1.5 years of age (Trainer 1971), a study on Vancouver Island (Janz and Becker 1986) found that no yearling females were pregnant. About 90% of mature cows become pregnant during favourable conditions: mild winters, good habitat quality, and an adequate supply of mature bulls for breeding.

A single calf is born in late May or early June after a gestation period of about 255 days (Trainer 1986). Twin calves have not been recorded on Vancouver Island. Cow elk usually produce a calf each year throughout their life, which may last up to 20 years. Cows give birth in solitude to avoid predators that are attracted to large, highly visible groups of elk. The vulnerable calf remains hidden during its first 10 days to 3 weeks of life, until it is relatively mobile. Cows and calves then join into groups again.

Reproductive success in elk can be influenced by a number of other factors (winter severity, predation, diseases, and parasites) that affect pregnancy, birth, and calf survival rates (Figure 49). The nutritional condition of the cow, however, is the key factor affecting reproductive success. High-quality habitat allows elk to build abundant reserves of energy (in the form of body fat) from spring through fall, and also slows the depletion of these reserves during winter. Populations in good physical condition have higher pregnancy rates and a larger proportion of breeding yearling and 2-year-old females (Trainer 1971). Calves born to cows that have access to high-quality winter forage weigh more at birth, which improves their chances of survival early in life (Thorne *et al.* 1976). They also have larger fat reserves at the onset of their first winter if they have fed on high-quality milk and abundant, nutritious forage during summer and fall. On extremely poor winter ranges, cows may become pregnant but abort during gestation (McNeill 1972).

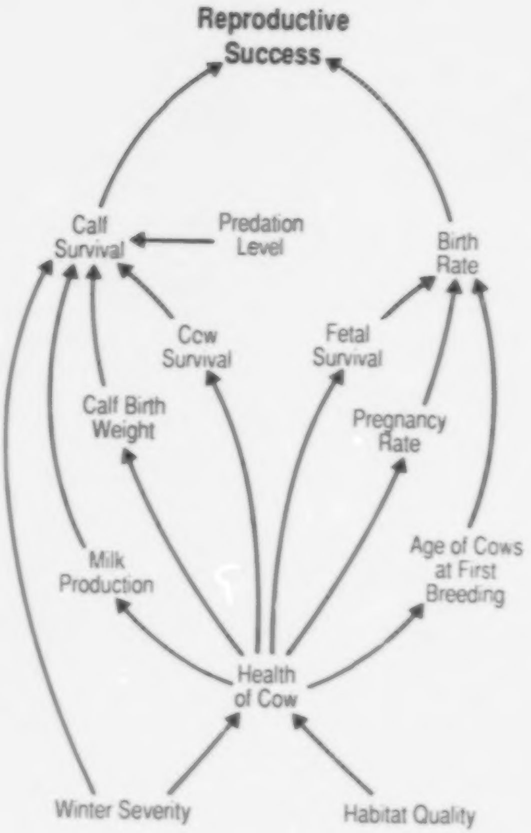

Figure 49. How habitat quality and winter severity influence the reproductive success of elk.

When habitat conditions are favourable and little mortality from hunting or predation occurs, elk populations can increase by as much as 30% per year (Raedeke *et al.* 1986). Overwinter mortality is generally the most significant factor regulating elk population levels. During the severe winter of 1968-69, about 50% of the elk on southern Vancouver Island died (G.W. Smith, pers. comm., 1986). A smaller proportion of the population often succumbs to malnutrition even during relatively mild winters.

survive adverse conditions, particularly in the absence of good winter range, is severely reduced when parasite loads increase as a result of poor animal condition (Cowan 1951).

Maximum life expectancy for elk on Vancouver Island is about 18 years for bulls and 22 years for cows, although average life spans are probably less than half these values. Mortality rates of bulls are higher than those of cows because bulls suffer greater hunting pressure and stress from the rigours of the rut. During the rut, bulls eat little and expend a great deal of energy. This results in greater over-winter mortality because adult bulls enter the winter with substantially less body fat than do cows (Newman 1958; Flook 1970). Mortality rates are highest among juveniles, with as few as 30% of elk on Vancouver Island surviving their first year even during relatively mild winter conditions (Janz and Becker 1986). During severe winters, calf survival is even lower, particularly on poor winter ranges.

ELK REQUIREMENTS

Elk require three basic resources to survive and reproduce successfully: water, food, and cover. Drinking water is abundant on Vancouver Island and the coastal mainland and it is, therefore, not considered when managing habitat. It is important to realize, however, that a change in natural drainage patterns could affect elk by altering associated vegetation.

Food

Food supplies all of the energy, protein, minerals, and trace elements required by elk, and much of the moisture. On Vancouver Island, elk find especially favourable feeding habitats in open conifer stands (<70% canopy closure), stands dominated by deciduous trees (>50% deciduous), and four special habitats:

1. non-forested wetlands (wetlands, meadows, and estuaries);
2. riparian areas (i.e., areas adjacent to and influenced by free water);
3. vegetated slides on summer ranges (Figure 51); and
4. around the borders of south aspect (110-250°) rock outcrops on winter and spring ranges.

The actual quality and quantity of forage occurring in a stand, particularly one dominated by conifers, is strongly influenced by the understory type present, the successional stage, and its forest management history (see Chapter 5).

As with deer, the four-part stomach of elk allows them to obtain nutrients by digesting complex carbohydrates such as cellulose, a major component of vascular plants (see p. 38). Because the rumen:body-weight ratio is higher in elk than in deer (Hanley 1982; Bunnell and Gillingham 1985), elk are able to digest relatively larger amounts of coarse forage without running short of incoming energy. They can therefore eat more low-energy foods than deer, particularly grasses, sedges, and hemlock foliage during fall and winter (Rochelle 1980; Janz 1983; Brunt *et al.* 1989).

The two major benefits elk receive from forage are energy and protein. As described in Chapter 2, the availability of energy to any ruminant depends on the digestibility of the dry matter in forage plants. Dry-matter digestibility varies throughout the year, reaching its lowest level during winter. On Vancouver Island, digestibility of elk winter forage falls as low as 32% during moderately severe winters (Janz 1983), well below the 50% level required for minimum body maintenance in ruminants (Ammann *et al.* 1973).

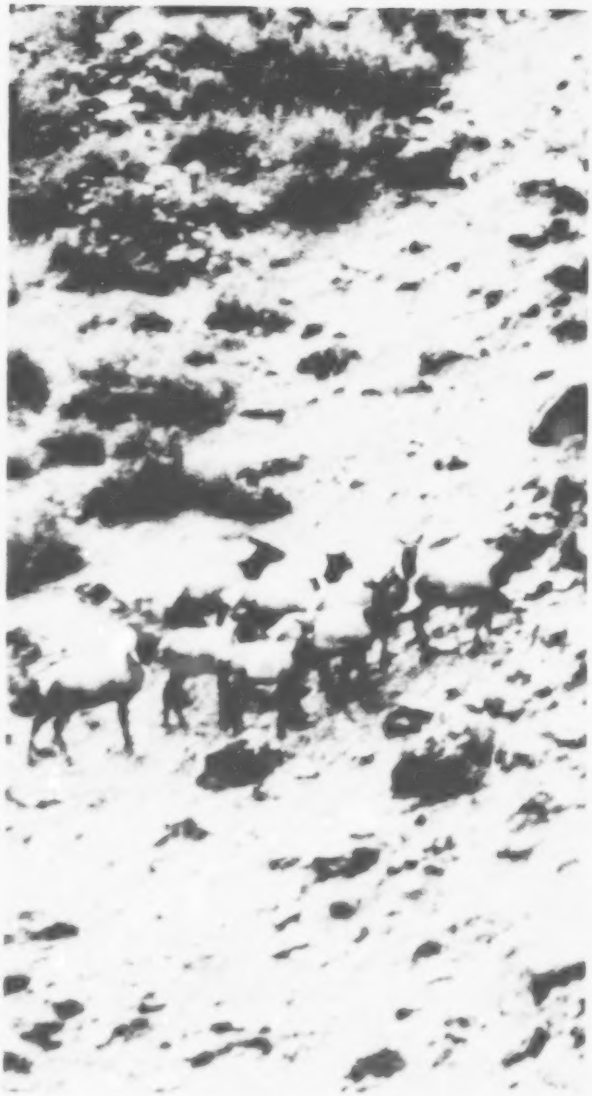

Figure 51. Vegetated slides at the heads of river valleys are key components of summer range for many elk on Vancouver Island.

Because digestibility of forbs and grasses is higher than that of conifers and shrubs (Janz 1983), mild winters with little snow allow greater levels of energy intake (Brunt *et al.* 1989) (Figure 52).

Protein content also varies among forage species, seasons, and individual plant parts, reaching its lowest level during winter. On Vancouver Island, elk winter diets have estimated protein levels of around 7.0-8.0% (Janz 1983; Brunt *et al.* 1989) which are greater than the 5.5% level estimated as a minimum requirement for pregnant cow elk (Nelson and Leege 1982) (Figure 53). However, some forage species possess protein levels well below this value (Janz 1983) and if elk were required to restrict their diet to these poor quality forage species, survival and productivity might be affected.

Diet selection and forage quality

Elk meet their food requirements by selecting their diets from a wide variety of potential forage species available in the plant communities they inhabit. The factors that influence their diet selection include forage availability, digestibility, nutrient concentration, and palatability.

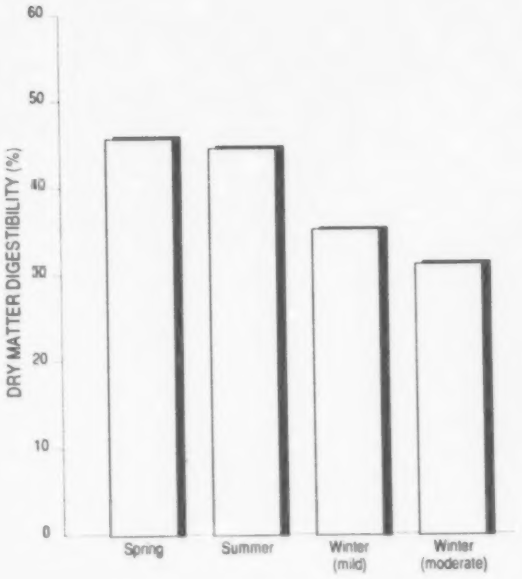

Figure 52. Estimated dry matter digestibility (energy content) of seasonal elk diets on Vancouver Island during a series of mild winters (Brunt et al. *1989). Also indicated is a value estimated during a moderately severe winter (January 2, 1983).*

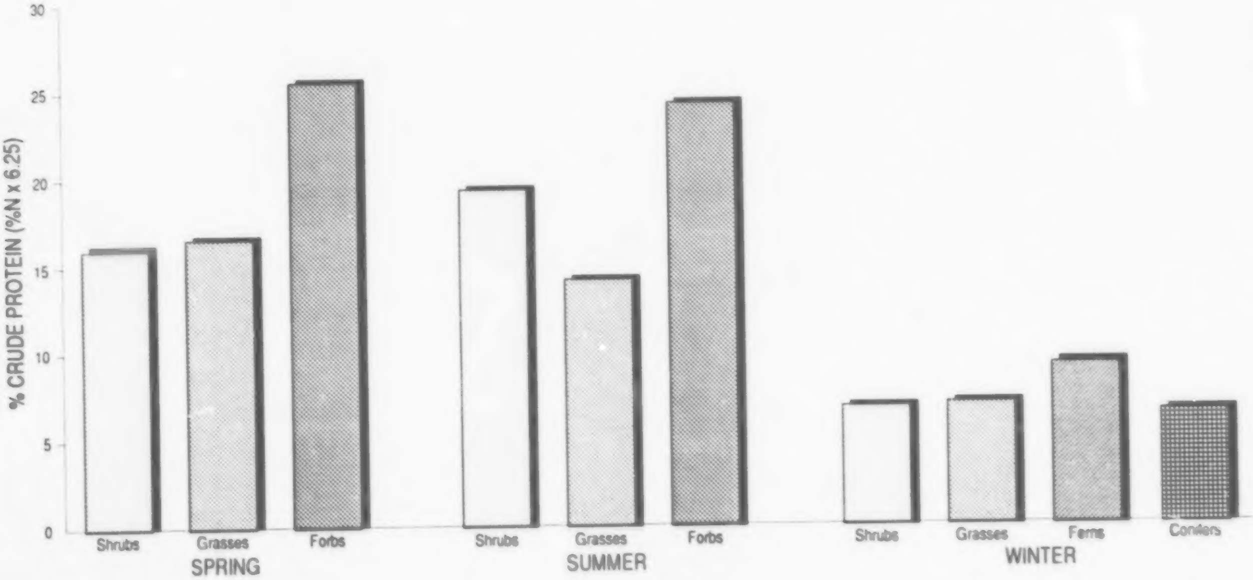

Figure 53. Seasonal variations of protein (nitrogen) levels of elk forage types on Vancouver Island elk ranges (from Janz 1983).

Variations in these factors lead to seasonal shifts in the importance of the major classes of forage (Figure 54) and in the selection of specific foraging areas. The most important elk forage species for each season are listed in Table 6, and the forage-producing capabilities of the understory types are listed in Table 7.

When only forage of sub-maintenance energy (i.e., <50% digestibility) or protein (i.e., <5.5% protein) content is available, elk lose weight rapidly as bodily reserves are used up. Most members of the deer family, including elk, experience an over-winter loss of weight each year (Nelson and Leege 1982). If forage quality remains low for extended periods of time, fat reserves will be depleted and extensive catabolism of body tissues (mostly muscle) may occur to meet the energy deficit. Spring calf production and survival rates are affected when over-winter weight loss by adult cows exceeds 15% (Thorne *et al.* 1976), and individual mortality during the winter is highly likely when weight loss exceeds 30% (Verme and Ullrey 1972). Calves typically enter their first winter with smaller bodily reserves of energy than adults and usually suffer greater winter mortality (Nelson and Leege 1982).

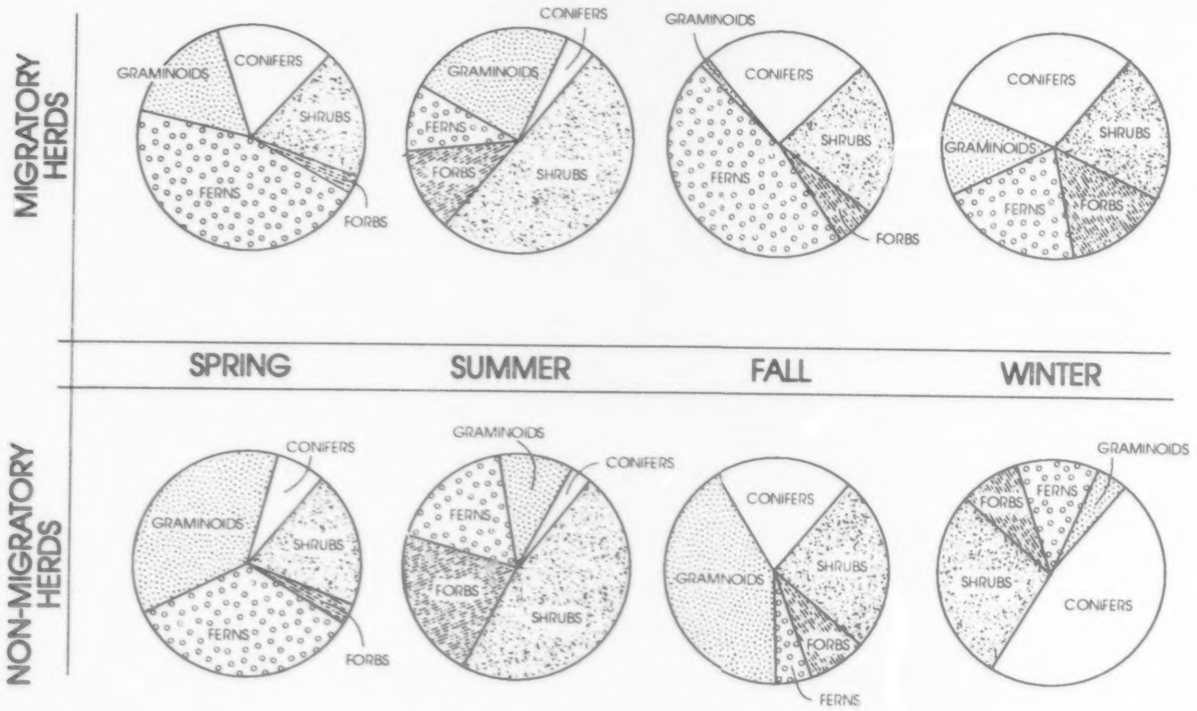

Figure 54. Composition of seasonal diets for two migratory and two non-mgratory elk herds on Vancouver Island (from Brunt et al. *1989).*

Table 6. Important forage plants for Roosevelt elk on Vancouver Island.[a] The most important or preferred species are printed in bold type.

	Winter	Spring	Summer
TREES	amabilis fir Douglas-fir **western hemlock** western redcedar	**amabilis fir** Douglas-fir **western hemlock**	**amabilis fir** western hemlock western redcedar
SHRUBS	devil's club **dull Oregon-grape** **Pacific ninebark** **red elderberry** *Rubus* spp. (salmonberry, blackberry, thimbleberry, raspberry, bramble) salal twinflower ***Vaccinium* spp.** (blueberry, huckleberry, cranberry) **willow spp.**	devil's club hardhack Pacific ninebark **salmonberry**	**bunchberry** devil's club dull Oregon-grape Pacific ninebark red elderberry **salmonberry** **twinflower**
FERNS	**deer fern** lady fern **sword fern**	**deer fern** **sword fern**	**deer fern** lady fern **sword fern**
HERBS	**grass spp.** **sedge spp.** skunk cabbage	bunchberry **grass spp.** **sedge spp.** skunk cabbage	**grass spp.** **sedge spp.** skunk cabbage wall lettuce

[a] References: Janz 1983; Brunt *et al.* 1989.

Table 7. Relative values of each understory type for potential production of elk forage. The forage values represent each type's potential at its peak of forage production.

Understory type	**Potential forage value**		
	Winter	**Spring**	**Summer**
Black huckleberry - White-flowered rhododendron	Low	Low	Low
California brome	Low	Low	Low
Deer fern	High	High	High
Huckleberry - Dull Oregon-grape	Moderate	Low	Low
Huckleberry - Moss	Moderate	Moderate	Moderate
Huckleberry - Rosy twistedstalk	Low	Moderate	Moderate
Indian hellebore	Low	Low	Low
Lichen - Falsebox	Low	Low	Low
Lichen - Moss	Low	Low	Low
Lichen - Pink mountain-heather	Low	Low	Low
Lichen - Prince's pine	Low	Low	Low
Lichen - Salal	Low	Low	Low
Moss	Low	Low	Low
Moss - Dull Oregon-grape	Low	Low	Low
Moss - Falsebox	Low	Low	Low
Moss - Kinnikinnick	Low	Low	Low
Mountain-heathers	Low	Low	Low
Oak fern	Low	Low	Low
Ocean-spray - Tall Oregon-grape	Low	Low	Low
Rosy twistedstalk - Five-leaved bramble	Low	Moderate	Moderate
Salal - Dull Oregon-grape	Moderate	Low	Low
Salal - Huckleberry	Moderate	Low	Low
Salmonberry - (Devil's club)	High	High	High
Sitka valerian - Arnica	Low	Low	Low
Skunk cabbage	High	High	Moderate
Sphagnum	Low	Low	Low
Sphagnum - Deer fern	Low	Low	Low
Sphagnum - Hardhack	Low	Low	Low
Sword fern	High	High	High

Winter forage

Elk diets in winter are usually much less diverse than those of other seasons. Annual plants have died completely back and many short forage plants are buried by snow. In mild winters with little or no snow, elk rely heavily on grasses, sedges, deer fern, and twinflower. Species that are most common on moist sites, including willows, cottonwood, elderberry, and devil's club, are commonly eaten throughout winter; so are more common shrubs such as salal, dull Oregon-grape, red huckleberry, and oval-leaved blueberry. When snow accumulations exceed about 30 cm, however, much more conifer foliage is eaten. Western redcedar and western hemlock can make up 40% of the late winter diet when snowpacks persist. Estimated values of protein and digestible energy levels in winter diets are 7.0-8.0% and 31-35%, respectively (Janz 1983; Brunt *et al.* 1989).

Spring and summer forage

Spring diets are dominated by shrubs, ferns, and grasses (Table 6). Important species include deer fern (which alone can account for up to 40% of the spring diet), bunchberry, various grasses and sedges, and sword fern. Young skunk cabbage shoots, which are among the first signs of new spring growth, are also highly preferred in the early spring. Spring diet protein levels are estimated at 15-19% and digestible energy levels at 42-48%.

Shrubs and herbs are most heavily eaten during summer, and often include salmonberry, ninebark, red elderberry, and bunchberry. Moderate amounts of grasses and sedges are also taken, along with all species of available ferns. Summer diets contain an estimated 15-17.5% protein and 42-45% digestible energy.

As annual plants begin to die back in late summer, diets show a marked increase in the proportion of conifers eaten. Amabilis fir, western hemlock, and western redcedar are usually preferred over Douglas-fir. Deer fern remains a highly preferred species, and alone may constitute up to 60% of the fall diet.

Management implications

The various microbes in the elk rumen differ in their abilities to break forages down to a usable form and to synthesize the amino acid building blocks of the different proteins that elk require. A diverse diet is necessary to maintain a diverse community of microbes in the rumen, thus ensuring that different types of forage can be digested and all required proteins synthesized. This has important forest management implications as it suggests that diverse plant communities or a variety of habitat conditions must be maintained if elk productivity is to be optimized. Efforts at improving forage should be focussed on preferred, high-quality species, but not to the extent that foraging areas are converted to single-species pastures. Seeding of grass and legume mixtures to enhance big game forage has been carried out in coastal Oregon since the early 1950's (Ramsey and Krueger 1986). The specific mixtures used depend on the big game species involved, the target season, forestry considerations, and whether or not cattle are sharing the range.

Furthermore, the survival and productivity of elk populations depend largely on the quantity and quality of forage they are able to obtain throughout the year. Good winter range helps to reduce winter mortality by slowing the rate of energy (fat) loss. High-quality spring range allows elk to replenish body reserves quickly, and good summer range allows them to rebuild large stores of fat for the following winter (Figure 55). Abundant, high-quality food on one seasonal range can compensate to some extent for poor forage on another seasonal range. Changes in forage quality on one seasonal range may have a disproportionately beneficial or detrimental effect on the local elk population.

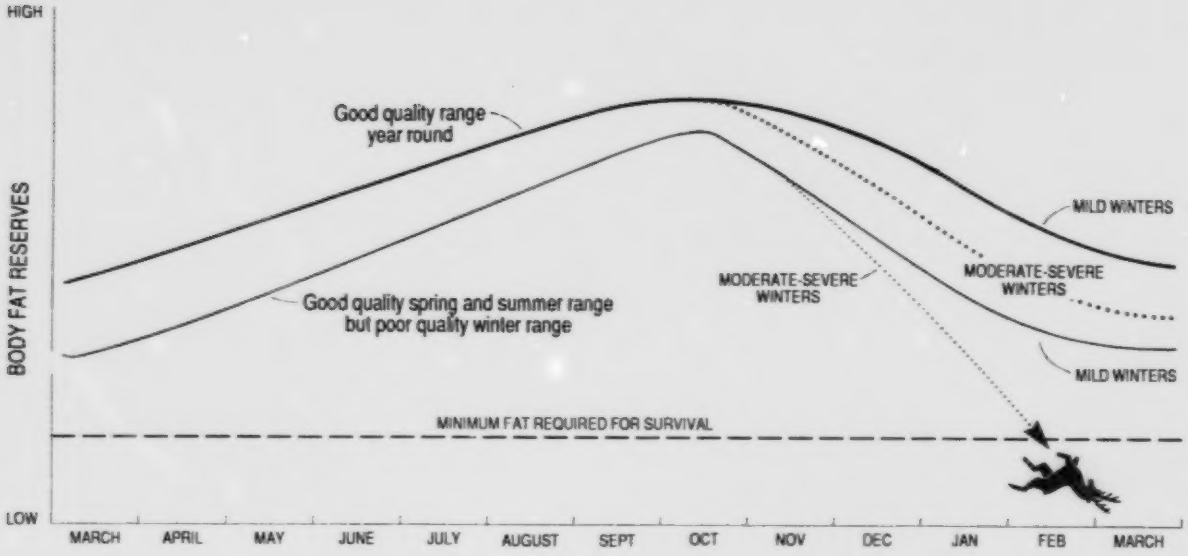

Figure. 55. Effects of poor-quality seasonal ranges on the annual level of body fat reserves of elk. Even when two seasonal ranges possess good habitat, malnutrition can still occur in moderate and severe winters if the third seasonal range has poor habitat.

Cover

Elk use both vegetative and topographic features of habitat as cover. These features allow elk to conserve energy, to escape predators and hunters, and to gain access to forage when snow restricts movement or buries the shortest food plants. Three types of cover are recognized in coastal British Columbia: security cover, thermal cover, and snow interception cover.

Security cover

Security cover provides elk with a sense of security or a means of escape from the threat of predators or harassment (Skovlin 1982). When they are in good security cover (rather than more exposed habitat), elk allow people and predators to approach more closely before fleeing, and they subsequently travel a shorter distance before stopping. The availability of security cover thus helps to minimize the expenditure of energy caused by long flights from distant disturbances.

The primary factors influencing a stand's value as security cover are the density and diameter of trees and the density of understory vegetation. It is widely accepted among biologists elsewhere that a minimum standard for adequate security cover is vegetation capable of hiding 90% of a standing adult elk from view at a distance of 200 ft (61 m) or less (Thomas *et al.* 1979). This definition was developed from field work with Rocky Mountain elk and mule deer and has not been carefully evaluated on the coast. Field observations from Vancouver Island indicate, however, that stands meeting this standard are adequate as security cover for Roosevelt elk. In fact, many coniferous stands with canopy closure greater than 60% will function as security cover if they are more than 3 m tall and 100 m wide (Figure 56). The minimum height insures that a standing elk will be concealed; the minimum width ensures that elk in the centre of the cover patch will be hidden from view from all sides. Stands with little understory vegetation and no live branches below 3 m height (i.e., where only tree boles provide "visual screening") must be very

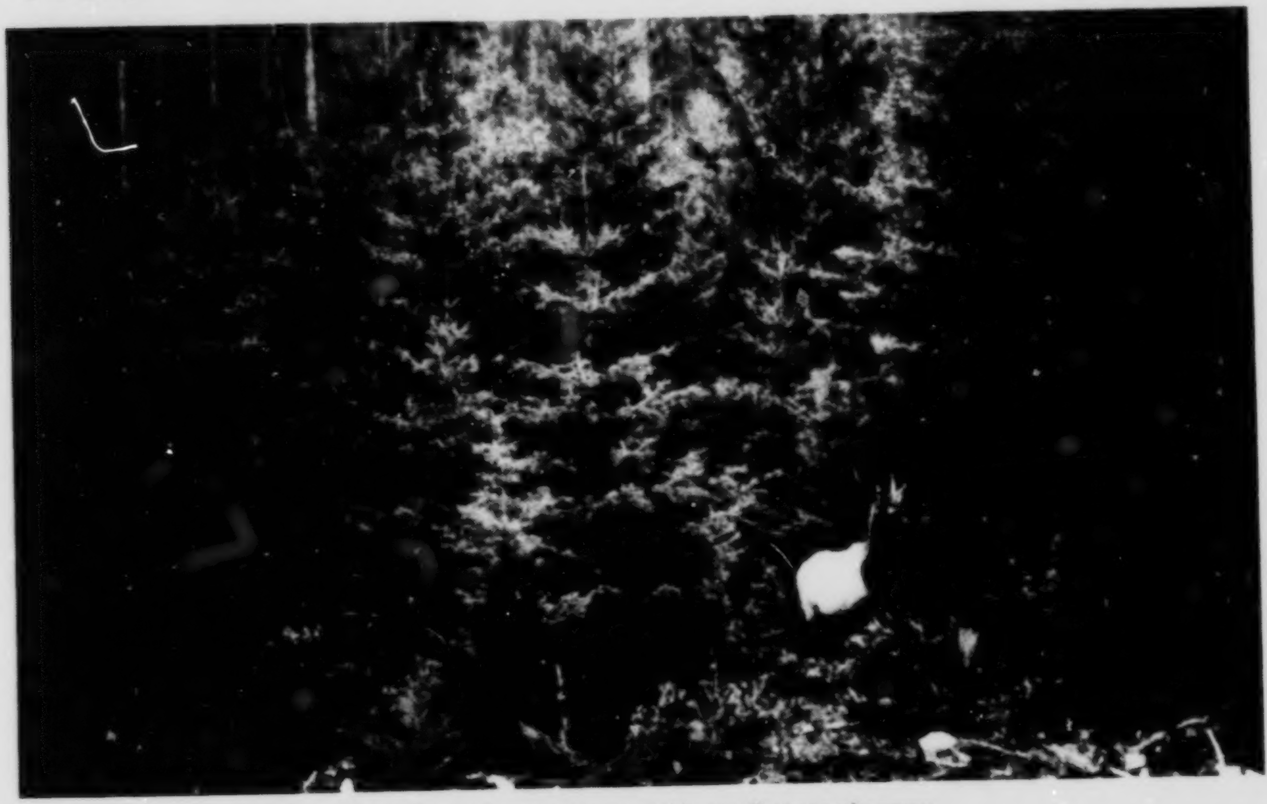

Figure 56. Dense stands of conifers at the sapling-pole stage provide excellent security cover.

dense to function as security cover. Smith and Long (1987) estimate that the total of diameters at breast height in a stand must exceed 311 m/ha for tree boles alone to provide security cover.

In some instances, however, a relatively narrow band of forest can function as security cover. For example, a band of trees left between a road and a heavily used foraging area, such as a wetland, may be all that is necessary to encourage elk use if the trees provide an effective visual screen which conceals the wetland from the road, and if a larger patch of security cover is available adjacent to another portion of the foraging area. Topographic diversity may also enhance an area's security cover characteristics.

Elk often bed down in security cover where they are hidden from view, but where they have a vantage point from which to watch for potential danger. Because open forage areas are not used heavily unless security cover is available nearby, the provision of security cover near forest openings is an important habitat management issue.

Thermal cover

Like deer and all other warm-blooded animals, elk must expend energy to maintain a constant body temperature. The amount of energy expended is similar throughout a range of ambient temperature known as the thermoneutral zone. When the temperature experienced by elk falls below the lower limit or rises above the upper limit of the thermoneutral zone (the upper and lower critical temperatures, respectively), more energy must be expended to maintain body temperature (Figure 57).

Upper and lower critical temperatures are not constant. They vary as a result of factors such as seasonal pelage (critical temperatures are higher in summer than in winter), body size (calves have narrower thermoneutral zones than adults), and the availability of forage (fasted elk are less able to withstand temperature extremes) (Bunnell *et al.* 1985b). Thermal cover allows elk to stay near or within their thermoneutral zone by ameliorating excessive temperature, wind, and precipitation.

For young Rocky Mountain elk in winter, values of around -20°C and 15-20°C were noted as lower and upper critical temperatures in still air, respectively (Parker and Robbins 1984). Air temperatures on Vancouver Island elk ranges rarely fall below -20°C. However, the effective temperature experienced by an elk (called the "operative temperature") is influenced by a number

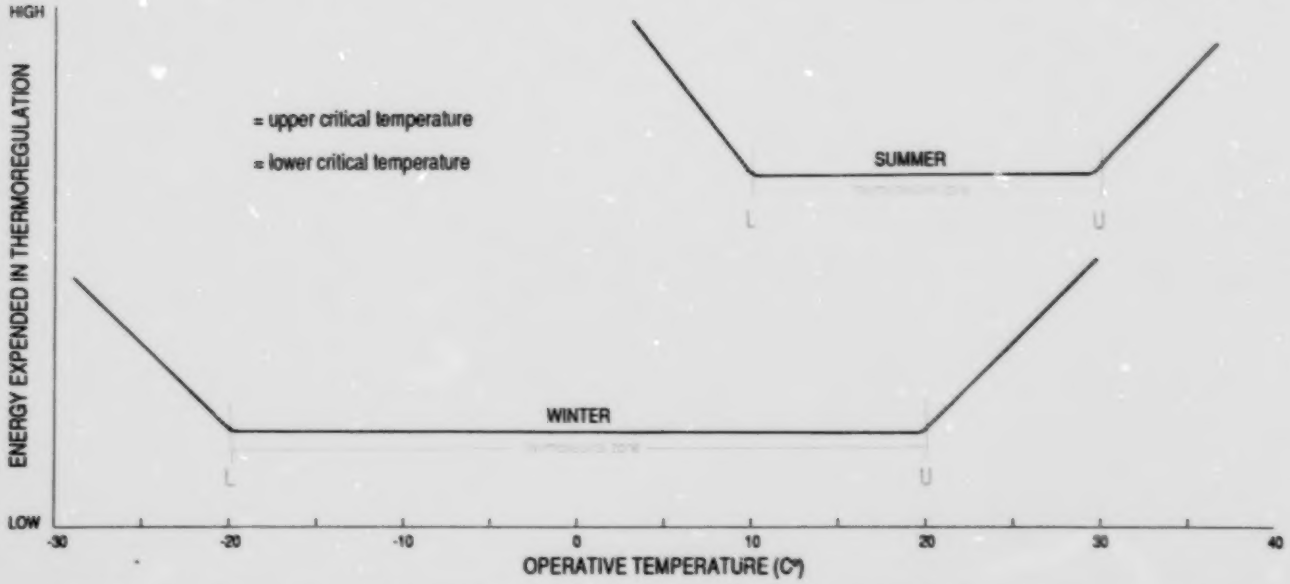

Figure 57. Generalized relationship between the energetic costs of thermoregulation for elk in summer and winter as a function of operative temperature (modified from Parker and Robbins 1984).

of factors including wind, air temperature, radiation, and humidity. For example, the cooling effects of wind and rain decrease the operative temperature and cause elk to expend extra energy at air temperatures well above -20°C. Wet animals exposed to wind would probably experience thermal stress at air temperatures even above freezing (Bunnell *et al.* 1985b). Conversely, solar radiation on south-aspect rock outcrops increases the operative temperature elk experience when they use these habitats on clear, cold, winter days.

During summer, elk appear to tolerate high temperatures better than deer because they sweat to dissipate heat, a less energetically expensive behaviour than panting (Parker and Robbins 1984). However, air temperatures greater than 25-30°C may cause elk to increase energy expenditures substantially. When still air temperatures fall below about 9°C in summer, energy costs also increase (Parker and Robbins 1984). As in winter, rain and wind may raise this lower critical temperature significantly.

On the coast of British Columbia, thermal cover for elk is provided by coniferous stands greater than 10 m tall with canopy closure exceeding 70%. Stands with these characteristics will ameliorate temperature extremes in both summer and winter and reduce excessive wind speeds. The dense overstory canopy will also reduce throughfall of precipitation.

Snow interception cover

The depth and density of snow significantly influence the costs of locomotion for elk (Figure 58). For example, elk expend around 5 times as much energy to travel through 58 cm of snow as they do when there is no snow (Parker *et al.* 1984). Snow also reduces the variety and quantity of forage available to elk by burying plants (Figure 59).

Snow depths of about 30 cm on Vancouver Island cause elk to shift use from relatively open wetlands and clearcuts to densely canopied forests and south aspect rock outcrops (Brunt *et al.* 1989). Elsewhere, snow in excess of 70 cm depth has been noted to present a serious physical limitation to elk

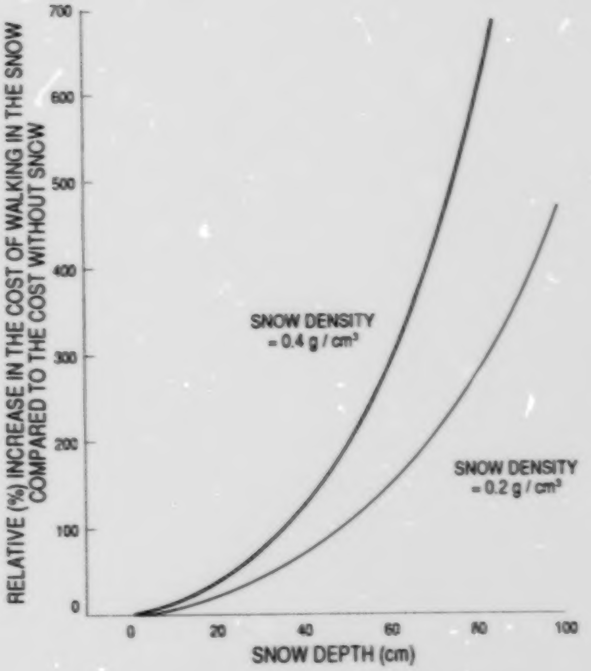

Figure 58. The relative increase in the cost of travel through snow as a function of snow depth (assuming elk sink through to ground level) in snow of two different densities (modified from Parker et al. *1984).*

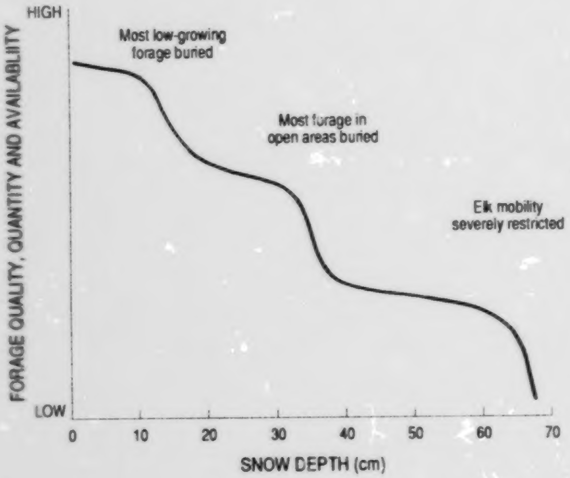

Figure 59. Generalized relationship between snow depth and forage quality, quantity, and availability.

movement (Sweeney and Sweeney 1984). The effect of snow on elk is determined not only by snow depth, however, but also by the length of time snowpacks persist. For example, elk would be stressed much more by a snowpack of 30 cm that persisted for 6 weeks than they would by a snowpack of 60 cm that remained for only 1 week.

Thus, where snow falls frequently, elk need areas of shelter with relatively shallow snow and with forage that remains unburied as long as possible. Coniferous stands at least 10 m in height and with a mean canopy closure of 60-90%, called snow interception cover, provide these conditions. As overstory canopy closure increases, snow is intercepted more efficiently (Bunnell *et al.* 1985a; McNay *et al.* 1988) but less forage grows in the understory. Stands with canopy closures of 60-90% provide both substantially reduced snow depths and adequate amounts of forage to maintain at least some elk through severe winters. Regenerating stands of trees at least 10 m in height have branches strong enough to resist bending and dropping intercepted snow to the ground during light or moderate snowfalls (McNay *et al.* 1988). During heavy snowfalls, old-growth trees may be superior in their ability to intercept and hold snow.

Several physiographic features enhance the ability of forest stands to function as winter habitat for elk. Stands on moderately sloped (10-50% slope), south-facing hillsides (110-250° aspect) receive increased amounts of solar radiation per unit area compared to flat areas and north-aspect slopes, and thus lose their snow more quickly during warm periods. Rock outcrops on such slopes are usually the first areas to be cleared of snow by the influences of solar radiation and wind. These outcrops and surrounding forest edges provide both forage and a favourable thermal environment during periods of snow melt, greatly increasing the value of south-facing hillsides as elk winter habitat. Old-growth forests are generally superior to regenerating stands in their ability to satisfy elk requirements when snowpacks are present. The multi-layered canopies, large branches capable of holding considerable snow loads, and small openings interspersed with more densely canopied patches in old-growth forests provide an excellent blend of snow interception and forage production capabilities. In the deep snowpack zone, old-growth stands may be the only habitats capable of supporting elk through severe winters.

The large size and herding behaviour of elk make them less susceptible than deer to excessive energy loss when they move through deep snow. The longer legs of elk make it easier for them to walk through snow, and their herding behaviour often results in single-file travel through deep snow so that only the individual in the lead expends the full amount of additional energy that would be used by a solitary animal. However, because of the greater weight per unit foot area of elk compared to deer, they usually sink to ground level regardless of snow conditions. Unlike deer, elk can rarely travel on top of the crusted snow which results from the rainfall and repeated freezing and thawing that often occurs on Vancouver Island winter ranges. Locomotion costs in crusted snow that cannot support an elk's weight are even greater than in uncrusted snow of similar depth (Parker *et al.* 1984).

Interspersion of Forage and Cover Areas

For elk to use food and cover resources efficiently, the resources must be distributed across the landscape in a pattern that encourages free movement of the animals through all areas. The interspersion of forage and cover within seasonal ranges is, therefore, a major influence on the quality of those ranges as elk habitat. Coastal forests generally provide abundant forage during early successional stages, but their ability to provide security, thermal, and snow interception cover develops later, after their canopies begin to close (Figure 60). Most young forests thus provide either forage or cover, not both. Patches of different successional stages must be located adjacent or near to each other to allow maximum use of all habitats. Elk habitat managers face a major challenge in attempting to plan their activities to satisfy elk requirements for food and cover, correctly interspersed through time, in the dynamic context of the managed forest.

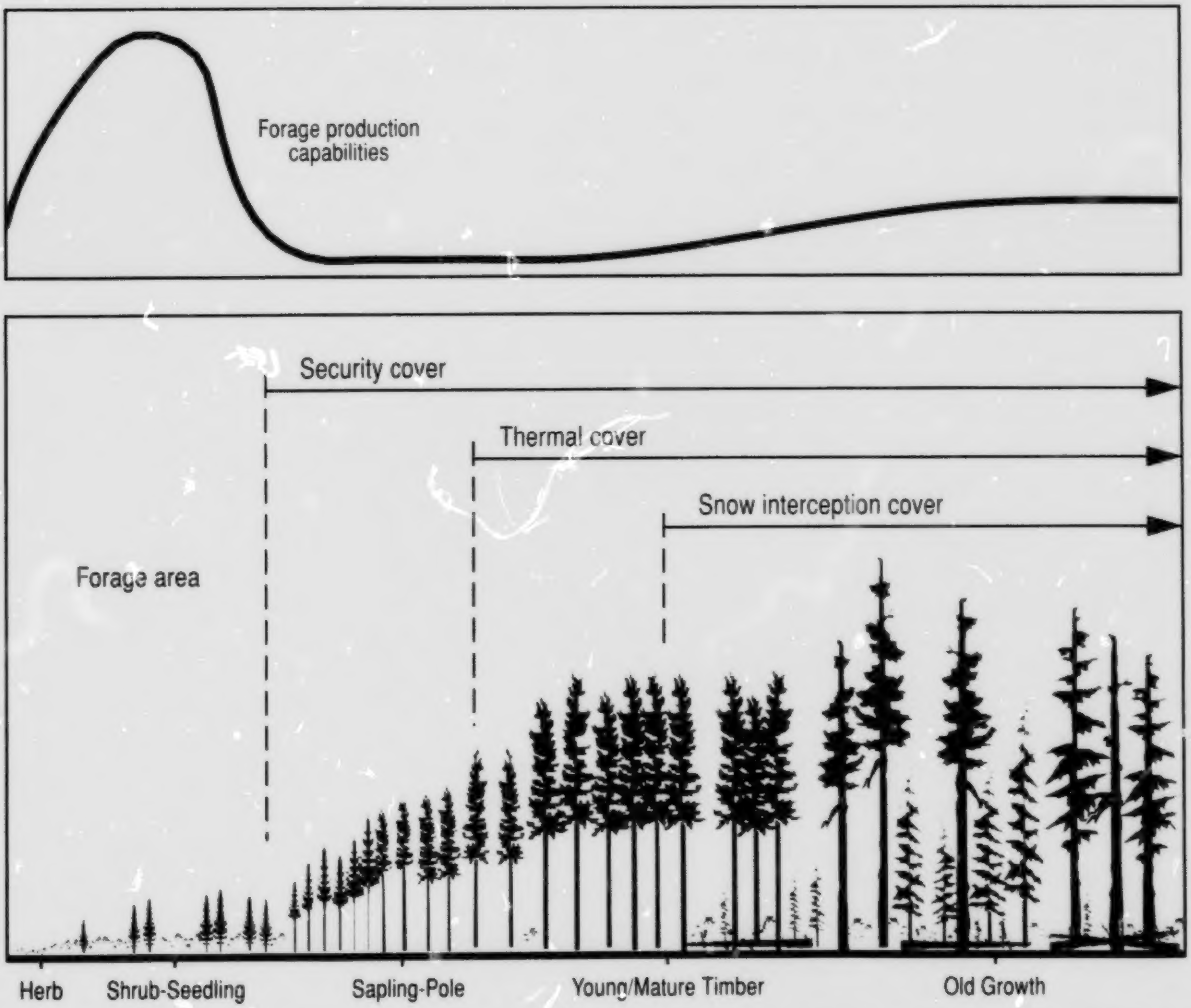
Forage production capabilities
Security cover
Thermal cover
Snow interception cover
Forage area
Herb
Shrub-Seedling
Sapling-Pole
Young/Mature Timber
Old Growth

Figure 60. Generalized relationship of a stand's ability to satisfy elk requirements through time (modified from Wisdom et al. *1986).*

Before the advent of modern forestry practices, the British Columbia coast was dominated by old-growth forests. Small natural openings such as wetlands, rock outcrops, vegetated slides, and burns provided some of the forage required by elk. Old-growth forests supplied additional forage (especially on rich riparian sites), security and thermal cover, and areas of reduced snow depth during winter. The managed forest of today, on the other hand, is increasingly dominated by large, relatively homogeneous stands with less structural diversity than old growth. Forestry practices, if planned so as to create a high degree of stand diversity across the landscape, can help to mitigate the impacts caused by loss of old-growth habitats (Figure 61).

Elk are an "ecotone species" whose habitat use is concentrated along the edge between relatively open areas that provide forage and densely forested areas that provide cover (Skovlin 1982). Many studies have found that elk use of both forage and cover areas declines as the distance from their common edge increases (reviewed by Witmer *et al.* 1985). In the Salmon River-Sayward Forest area of Vancouver Island, about 50% of elk use of forage areas takes place within 40 m of a forage/cover edge, and about 95% of use occurs within 200 m of such an edge. In patches of cover, about 50% of elk use occurs within 100 m and 80% within 200 m of an edge (Brunt *et al.* 1989) (Figure 62). This pattern of habitat use, commonly called the "edge effect," is usually attributed to the high vegetative diversity associated with edges and the need for ready access to all requirements of life (Thomas *et al.* 1979). Energy can be conserved because less travelling is necessary when resources are closely interspersed, and predators or human disturbance can more easily be avoided when cover is available near open foraging areas.

Consequently, when all required resources are closely interspersed within a seasonal range, groups of elk can satisfy their requirements within smaller areas and the range can support a larger population. In the managed forest, habitat quality for elk will be maximized if forestry activities are planned to maintain a forage/cover edge within 200 m of all points within elk seasonal ranges. Because patches of security cover must be greater than 100 m in width (see p. 81) to be fully effective, there is a minimum limit on the appropriate size of cover areas.

The shape of patches of habitat can strongly influence the amount of edge and the interspersion of forage and cover. Figure 63 depicts four hypothetical shapes for a 36-ha clearcut surrounded on all sides by old-growth forest. A square block has 2400 m of edge, and a core area of 4 ha that is greater than 200 m from an edge (where little or no elk use will occur). The oblong rectangles of the same area increase the amount of edge and decrease the core area of minimal elk use. The irregular design with a maximum width of 200 m not only increases the amount of edge by about 60% over a square block design, but also ensures that all points in the foraging area will receive close to maximum use.

Thus, the width and shape of cover and forage areas are more important than their sizes. Patches of cover need to be at least 100 m and no more than 500 m wide to provide optimum elk habitat. Foraging areas, on the other hand, would have to be less than 80 m wide to receive maximum use. Narrow clearcuts of irregular shape could meet the requirements of good foraging habitat, while being very large in total area. Conversely, relatively small areas may contribute greatly, on a collective basis, to the available elk forage. A small opening in the canopy, such as that resulting from the death of a single tree in an old-growth stand, can result in a significant increase in forage production.

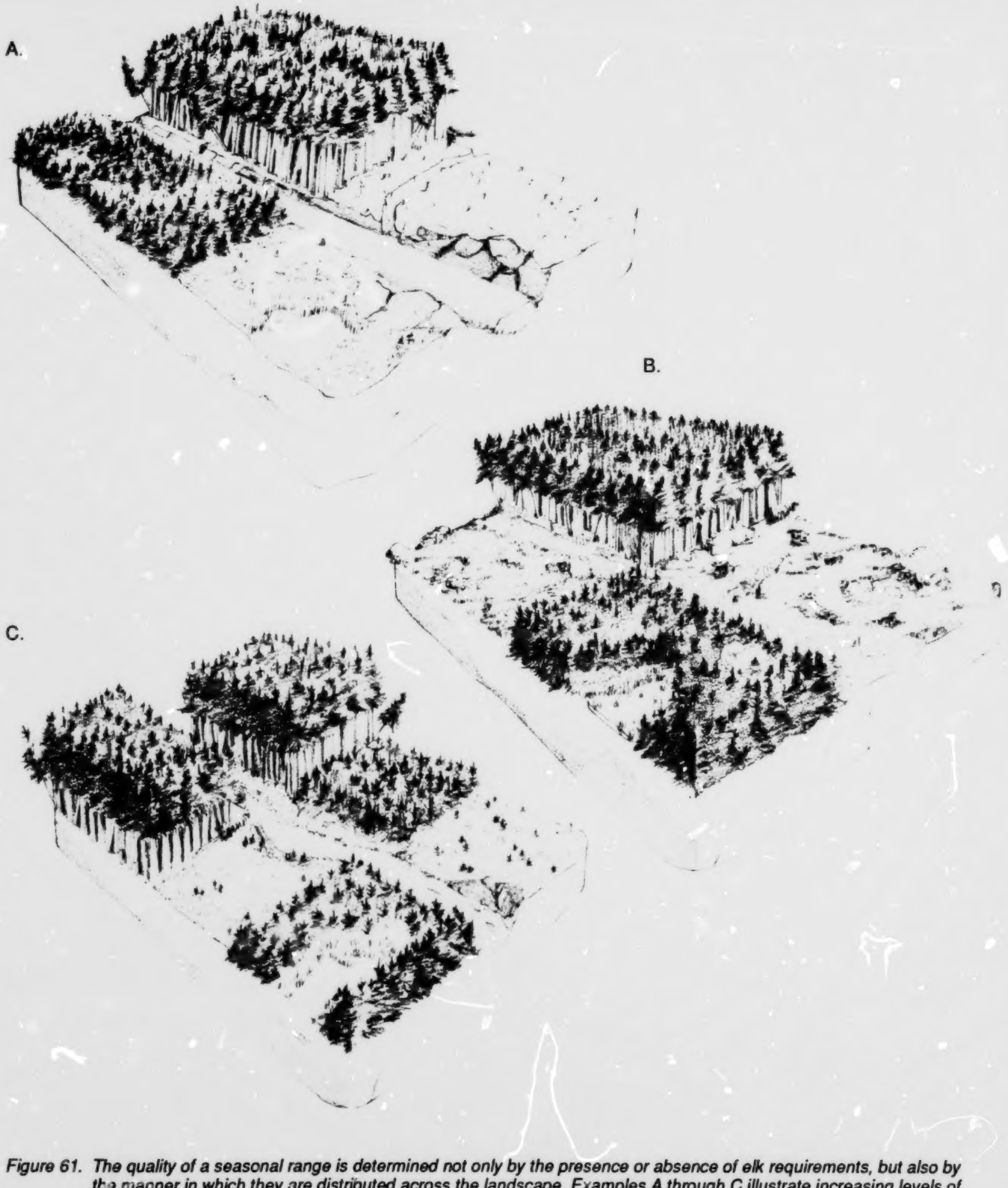

Figure 61. The quality of a seasonal range is determined not only by the presence or absence of elk requirements, but also by the manner in which they are distributed across the landscape. Examples A through C illustrate increasing levels of interspersion, which improves habitat quality even though the absolute quantity of the forage and cover habitats remains constant.

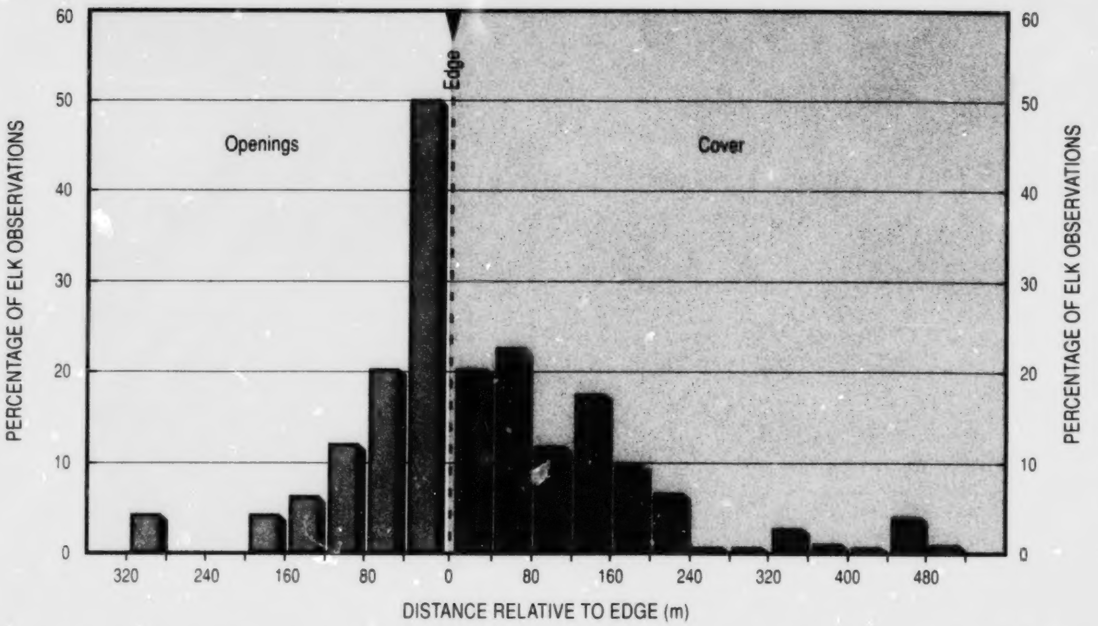

Figure 62. Distribution of elk radio-telemetry locations and visual observations in the Salmon River-Sayward Forest area relative to edges between openings and cover (Brunt et al. 1989). Forty percent of the area of openings and 50% of the area of cover patches was greater than 200 m from an edge.

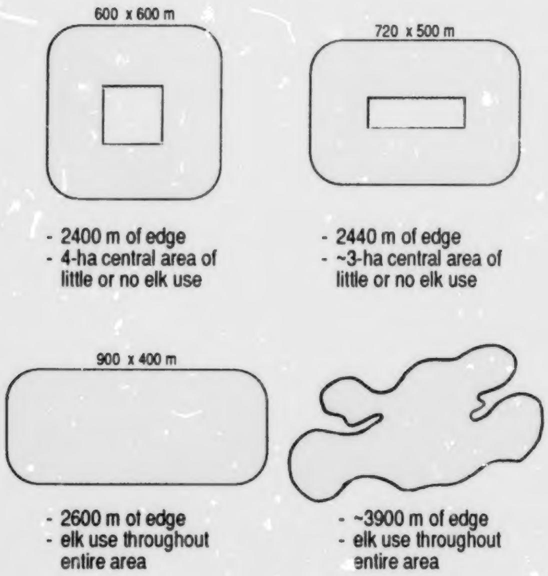
600 x 600 m
- 2400 m of edge
- 4-ha central area of little or no elk use
720 x 500 m
- 2440 m of edge
- ~3-ha central area of little or no elk use
900 x 400 m
- 2600 m of edge
- elk use throughout entire area
- ~3900 m of edge
- elk use throughout entire area

Figure 63. Four hypothetical layouts of a 36-ha clearcut illustrating how block shape can influence the amount of edge created, and the distance to edge within the stand.

MEETING THE REQUIREMENTS

Tactics of Habitat Selection

Elk, because they are adaptable, are able to satisfy their requirements from a broad range of habitats. As noted in earlier sections, however, there are minimum food and cover needs that must be met if elk are to survive and reproduce. Above those minimums, the number of elk which can be continuously supported by an area (its carrying capacity) depends on the habitat quality. Habitat quality is determined by the density of required resources. As resource density increases, elk can satisfy their needs in a smaller area and the carrying capacity of the range increases.

The locations of individuals or groups of elk at any time reflect the process of habitat selection through which elk select specific areas of the landscape that will satisfy their requirements in an energetically efficient manner. Habitat selection occurs at several levels:

1. at the level of the annual home range, encompassing all areas used through the year;
2. at the seasonal range level, which reflects habitat requirements that change with the seasons;
3. at the microhabitat level within seasonal ranges, where immediate requirements are satisfied; and
4. at the level of forage selection for individual plants or plant parts (Figure 64).

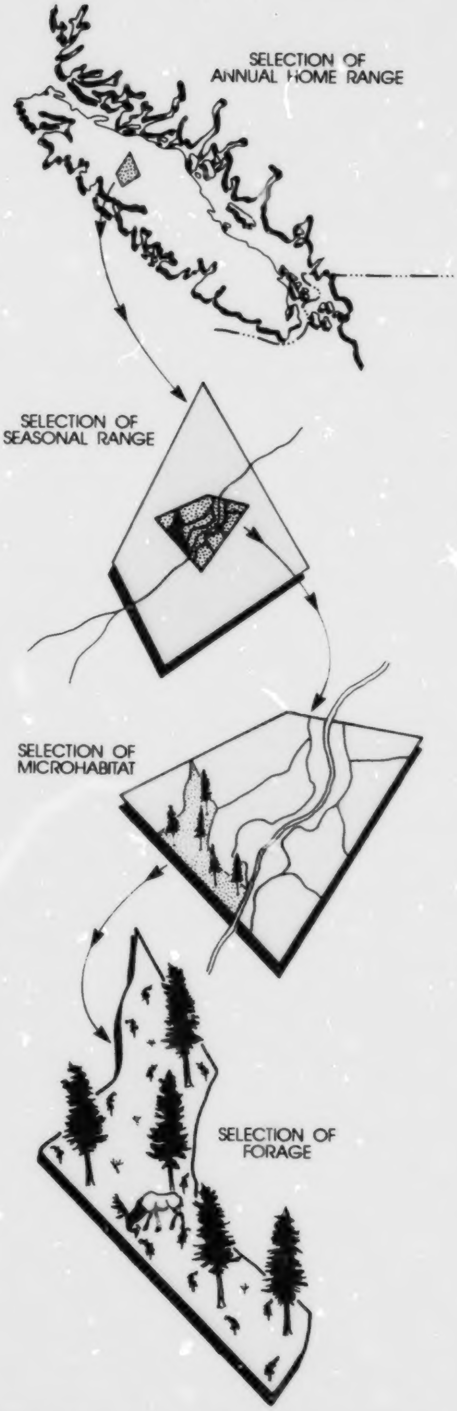
SELECTION OF ANNUAL HOME RANGE
SELECTION OF SEASONAL RANGE
SELECTION OF MICROHABITAT
SELECTION OF FORAGE

Figure 64. Various levels at which habitat selection can be viewed.

Migration and Seasonal Range Selection

The annual range of a herd of elk is usually similar from year to year. Most elk on Vancouver Island are migratory, occupying three distinct seasonal ranges during the winter, spring, and summer seasons. Migratory elk benefit from shallow snow depths on low-elevation winter ranges and abundant, diverse forage on higher elevation summer ranges. Also, because the elevation gradient and variety of aspects available on mountainous summer ranges provide elk with access to forage at various stages of phenological development, they can obtain succulent, newly emerging forage when many lower elevation plants have already matured and desiccated. Migration increases costs of locomotion and vulnerability to predation, however, so a net gain must be realized for migration to be a viable strategy. The annual range of migratory elk is simply the sum of all seasonal ranges and the migratory routes that connect them (Figure 65).

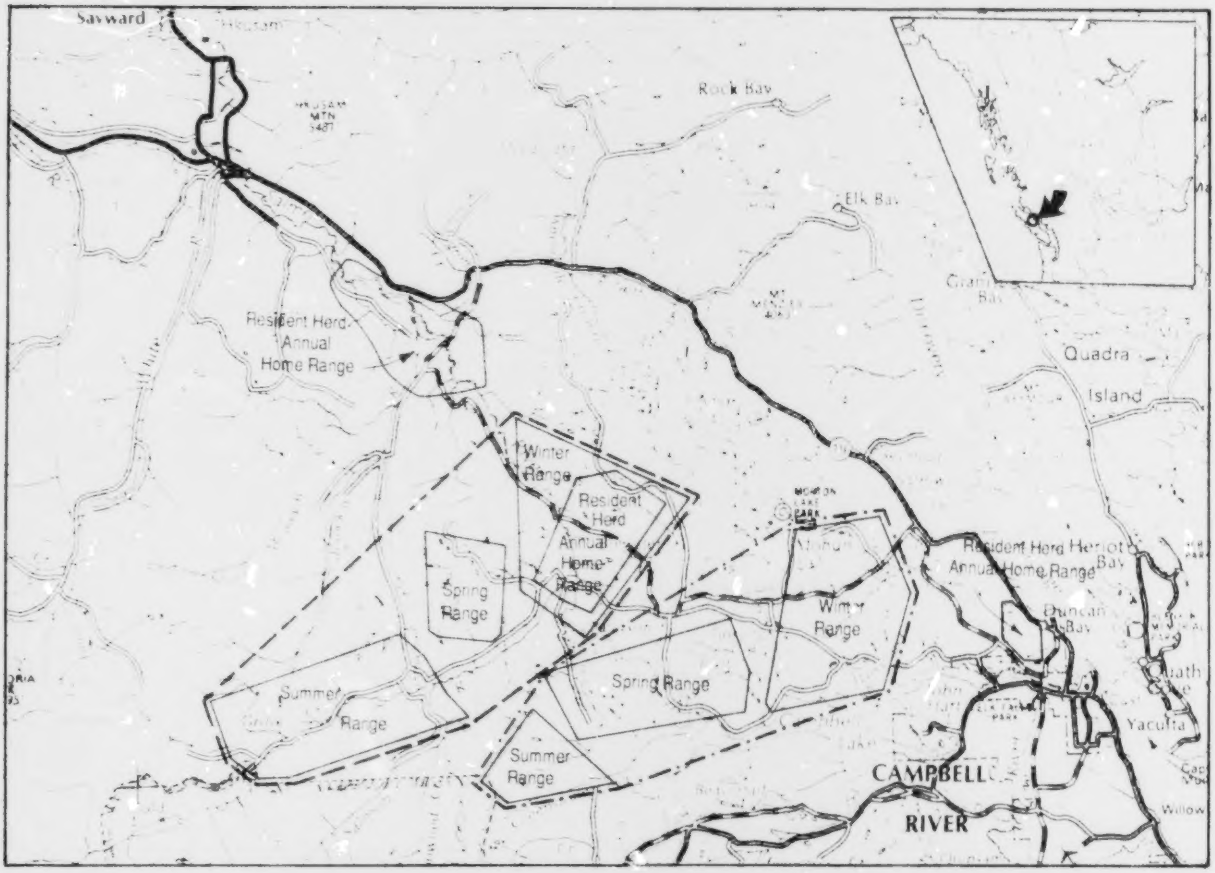
Sayward
Rock Bay
Elk Bay
Resident Herd Annual Home Range
Winter Range
Resident Herd Annual Home Range
Spring Range
Summer Range
Spring Range
Winter Range
Summer Range
Resident Herd Heriot Bay Annual Home Range
Granite Bay
Quadra Island
Duncan Bay
Yaculta
CAMPBELL RIVER
Willow

Figure 65. Seasonal and annual ranges of two migratory and three resident elk herds in the Campbell River area.

Non-migratory or "resident" elk also occur in favourable low-elevation habitats on Vancouver Island, but the greater number and size of the migratory herds suggest that migration provides a significant advantage in most areas. Resident elk herds occupy single ranges of about 5-10 km² at low elevations that satisfy all seasonal requirements and that sometimes overlap the winter ranges of migratory elk herds. Seasonal shifts in areas of concentrated use usually occur with seasonal changes in requirements for forage and cover. For example, seepage sites where skunk cabbage occurs are often heavily used in the early spring, while densely canopied stands which provide thermal cover are used most heavily during the summer and winter when thermal stress is greatest.

The seasonal ranges of a migratory herd are usually within the watershed of a single river, but can be separated by as much as 40 km. Individual seasonal ranges may be up to 30 km² in area. Winter ranges, usually occupied from November through March, occur at elevations from sea level to 600 m. Spring ranges are usually occupied for varying periods from February through April, depending on the timing of snow melt and the spring flush of forage growth. They may be part of, or adjacent to, winter or summer ranges, or occur at a point somewhere along the migratory route between the two. Spring ranges may also account for the entire migratory route between the winter and summer ranges. Summer ranges generally occur at elevations of 400-1500 m and are occupied for varying periods from late spring through fall (April-November).

Migration to the winter range is usually completed over a period of several weeks and seems to be triggered by decreasing forage quality and availability on the summer range as the growing season ends and snow covers forage plants. During spring migration, elk follow the retreating snow line and emerging forage to the summer range, where more abundant and nutritious forage allows them to replenish body reserves depleted during winter. The location of seasonal ranges and the migratory routes which connect them are learned by calves from their mothers or the groups with which they are associated (Geist 1982). Usually, individual elk make use of only a portion of the herd's seasonal range. They are often faithful to their own seasonal home ranges, returning to them repeatedly in successive years.

Seasonal ranges are usually large and may change over time as habitat quality or the size of the population changes. For example, the entire upper portion of a watershed may provide potential summer range even though it might currently be only partially used or even unused by elk. This has important implications to forest and wildlife managers, because forestry activities can be employed to expand existing seasonal ranges, to enhance the capabilities of currently unused range or to improve one seasonal range and so balance its carrying capacity with that of another seasonal range for the same elk population. Specific characteristics of seasonal ranges needed to satisfy elk requirements are covered later in this chapter.

Microhabitat and Forage Selection

To satisfy their day-to-day requirements for food, cover, and water, elk use relatively small areas within the seasonal range. The key features of these areas, called "microhabitats" here, seem to include features such as forage and cover edges, patches of abundant forage, and forest stands satisfying cover requirements. It is tempting but often misleading to think of elk selecting "stands" as defined on forest cover or other habitat maps. Elk microhabitats are selected according to elk, not human, perceptions. Nevertheless, certain types of microhabitats, such as snow interception cover, do correlate well to forest cover strata in some cases.

Forage is selected with every bite of food an elk takes, as individual plants or parts of plants are chosen or rejected based on size, quality, palatability, and other factors.

Management Implications

The manner in which elk satisfy their habitat requirements has some important implications for forest managers. Because elk requirements change with seasons, most elk on Vancouver Island are migratory, selecting separate seasonal ranges during the spring, summer-fall, and winter periods. To minimize the negative impacts and maximize the positive impacts of forestry activities, managers must identify the seasonal ranges that occur within the area being managed.

It is also important that managers realize that while seasonal ranges tend to be used traditionally, specific areas may be used to varying degrees (or not at all) in different years because of annual variations in weather conditions and elk behaviour. Summer ranges are probably least affected by this phenomenon but, during particularly hot summers, areas providing relief from thermal stress will receive greater use. The exact location of the winter ranges selected by elk is somewhat more variable, depending on annual variations in winter severity. Spring ranges usually show the greatest variability in location and time of use of the three seasonal ranges of migratory elk. A gradual loss of the winter snowpack results in a longer period of use of relatively larger spring ranges, while a rapid snow melt following a mild winter may result in elk using spring ranges for very short periods, if at all, before migrating to the summer range. Management efforts must consider annual variations, particularly in winter severity, when elk habitat quality is a concern.

Habitat management within the annual home range of a non-migratory elk herd is somewhat different than for seasonal ranges of migratory elk. Rather than concentrating on fulfilling requirements during a particular season, the manager needs to be concerned with satisfying year-round needs within a relatively small area. Usually a more complex mosaic of habitats must be provided to satisfy seasonally changing requirements of non-migratory elk.

HABITAT NEEDS ON SEASONAL RANGES

Winter Range

Winter is the most critical season for elk, as for deer. Forage is scarce and of poor quality, energetic demands are high, and snow restricts movement. To survive, elk must draw on fat reserves built up during the previous summer and fall. Adult bulls, weakened by the fall breeding season, and calves are usually the segments of the population most susceptible to malnutrition and winter mortality because they have small fat reserves to draw on.

High-quality winter ranges allow elk to minimize the amount of energy they expend while maximizing the amount of high-quality forage they take in. This helps reduce the depletion of body reserves and improves chances of survival. Many important elk winter ranges include rich, moist sites such as floodplains and other riparian habitats, but south-aspect slopes are also important, particularly in areas where deep snows commonly occur. Winds from the south are common on Vancouver Island and the coastal mainland, and sublimation of snow by wind can significantly reduce snow depths on exposed slopes. Incoming solar radiation per unit area is also greater on south-aspect slopes compared to flat or north-aspect areas. Snowpack accumulations are therefore shallower and elk are better able to absorb direct solar radiation on clear, sunny days on south-aspect slopes as compared to other areas.

Figure 66 depicts the important components of elk winter ranges. A few understory types with rich herbaceous communities provide the best winter forage potential (Figure 67). The importance of the various habitat features depends on which of the four snowpack zones the winter range lies in.

Shallow snowpack zone

On winter ranges in the shallow snowpack zone, snow interception cover is not an important consideration because snowfalls are infrequent and usually light, hence deep snowpacks are rare. Because of the lack of snow, elk are able to forage extensively in open areas. These include recently clearcut areas, especially where they occur on rich, moist sites with abundant preferred forage, and natural openings such as wetlands and rock outcrops. Open-canopied forests such as those with a large deciduous component, thinned young stands, and open old-growth stands are also heavily used for foraging.

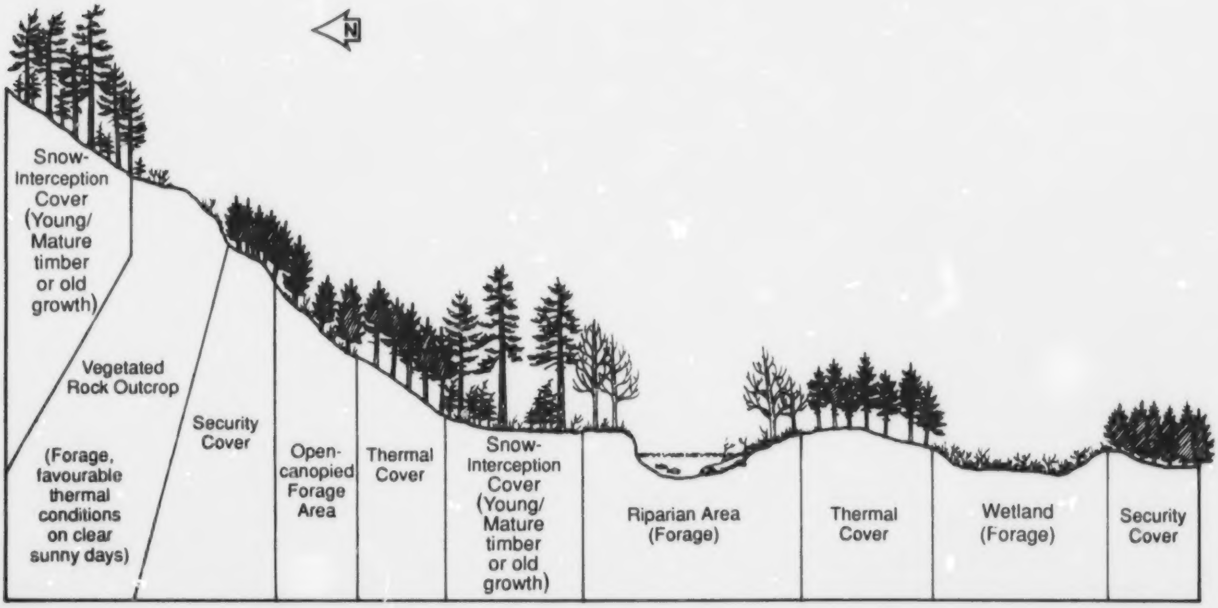
N
Snow-Interception Cover (Young/ Mature timber or old growth)
Vegetated Rock Outcrop
(Forage, favourable thermal conditions on clear sunny days)
Security Cover
Open-canopied Forage Area
Thermal Cover
Snow-Interception Cover (Young/ Mature timber or old growth)
Riparian Area (Forage)
Thermal Cover
Wetland (Forage)
Security Cover

Figure 66. Important components of elk winter range showing good interspersion of forage and cover requirements (not to scale).

Biogeoclimatic Units	SNR[1]	Soil Moisture Regime (Potential Hygrotope)[2]							
		0	1	2	3	4	5	6	7
CDFa[3] (CDFmm[4])	A B C D E	Lichen - Moss	California Brome		Salal - Huckleberry		Moss		Sphagnum - Hardhack
			Ocean-spray - Tall Oregon-grape		Salal - Dull Oregon-grape		Sword Fern		Skunk Cabbage
CDFb (CWHxm1)	A B C D E	Lichen - Salal			Salal - Huckleberry		Moss		Sphagnum - Hardhack
		Ocean-spray - Tall Oregon-grape			Salal - Dull Oregon-grape		Sword Fern / Salmonberry[5]		Skunk Cabbage
CWHa1 (CWHxm2)	A B C D E	Lichen - Salal		Salal - Huckleberry		Huckleberry - Moss	Deer Fern		Sphagnum - Hardhack
				Moss - Dull Oregon-grape			Sword Fern / Salmonberry[5]		Skunk Cabbage
CWHa2 (CWHdm)	A B C D E	Lichen - Prince's Pine	Salal - Huckleberry		Huckleberry - Moss		Deer Fern		Sphagnum - Hardhack
			Moss - Dull Oregon-grape				Sword Fern / Salmonberry[5]		Skunk Cabbage
CWHb1 (CWHvm1)	A B C D E	Lichen - Salal		Salal - Huckleberry	Huckleberry - Moss		Deer Fern		Sphagnum - Deer Fern
					Moss		Sword Fern / Salmonberry[5]		Skunk Cabbage
CWHb2 (CWHvm2)	A B C D E	Lichen - Moss	Moss		Huckleberry - Moss		Deer Fern	Sphagnum - Deer Fern	
							Rosy Twistedstalk - Five-leaved Bramble	Skunk Cabbage	
CWHb3 (CWHmm1)	A B C D E	Lichen - Salal	Salal - Huckleberry		Huckleberry - Moss		Deer Fern		Sphagnum - Deer Fern
			Salal - Dull Oregon-grape		Moss		Sword Fern / Salmonberry[5]		Skunk Cabbage
CWHb4 (CWHmm2)	A B C D E	Lichen - Moss	Huckleberry - Moss				Deer Fern		Sphagnum - Deer Fern
			Huckleberry - Dull Oregon-grape				Rosy Twistedstalk - Five-leaved Bramble		Skunk Cabbage
CWHb5 (CWHms1)	A B C D E	Lichen - Falsebox	Moss - Kinnikinnick		Huckleberry - Moss		Deer Fern		Sphagnum - Deer Fern
					Huckleberry - Rosy Twistedstalk		Oak Fern		Skunk Cabbage
CWHc1 (CWHds1)	A B C D E	Lichen - Prince's Pine			Moss - Falsebox		Moss		Sphagnum
		Ocean Spray - Tall Oregon-grape			Moss - Dull Oregon-grape		Oak Fern		Skunk Cabbage
CWHd1 (CWHvh1)	A B C D E	Lichen - Salal	Salal - Huckleberry				Deer Fern		Sphagnum
			Moss				Sword Fern		Skunk Cabbage
MHa	A B C D E	Lichen - Pink Mountain-heather	Huckleberry - Moss				Deer Fern	Sphagnum - Deer Fern	
				Huckleberry - Rosy Twistedstalk			Rosy Twistedstalk - Five-leaved Bramble	Skunk Cabbage	
MHb	A B C D E	Lichen - Pink Mountain-heather		Black Huckleberry - White-flowered Rhododendron	Huckleberry - Moss		Deer Fern		Sphagnum - Deer Fern
					Huckleberry - Rosy Twistedstalk		Rosy Twistedstalk - Five-leaved Bramble		Indian Hellebore
MHp	A B C D E	Lichen - Pink Mountain-heather	Mountain-heathers		Black Huckleberry - White-flowered Rhododendron		Sitka Valerian - Arnica		Indian Hellebore

1. Soil nutrient regime: A = very poor. B = poor. C = medium. D = rich. E = very rich
2. Soil moisture regime (Potential hygrotope): 0 = very xeric. 1 = xeric. 2 = subxeric. 3 = submesic. 4 = mesic. 5 = subhygric. 6 = hygric. 7 = subhydric
3. Codes for biogeoclimatic units from Green *et al.* (1984).
4. Revised codes for biogeoclimatic units.1988 (D. Meidinger. personal communication).
5. The Salmonberry (Devil's Club) type replaces the Sword Fern type on sites with a high water table.

☐ spring summer winter ☐ spring and winter

Figure 67. The best forage for elk is produced on rich, moist sites, in the highlighted understory types.

Security cover is also important, and can be found in stands providing a dense visual screen below 3 m height (usually formed by tree trunks, lower branches, or understory vegetation). Thermal cover may occasionally be required, but needs to form only a small portion of all the cover on a winter range. Only in areas with no stands taller than 10 m will lack of thermal cover normally be a concern.

Thus, elk benefit from stand conditions similar to those that favour deer wintering in the shallow zones:

1. heterogeneous forests providing a mixture of forage patches, security cover, and thermal cover within stands; and
2. areas where small clearcuts or natural openings are interspersed with patches of cover so that a forage/cover edge is no more than 200 m from any point.

Elk use wetland openings, riparian forests, and deciduous stands far more extensively than deer do, however.

Moderate and deep snowpack zones

During periods of shallow or no snow, which are common during winter even in the moderate and deep snowpack zones, elk forage extensively in openings and open forests, especially those on rich, moist sites. As in the shallow zone, natural openings and small clearcuts are both used. Severe winters with deep, persistent snowpacks occur occasionally in the moderate zone and frequently in the deep zone, however, so snow is an important factor influencing elk habitat use. Once snow accumulates to a depth of about 30 cm in open areas, most low-growing plants are covered. Elk then shift to forest stands and topographic sites with shallower snow. If necessary, elk will paw through as much as 40 cm of snow to reach grass and forbs beneath (Sweeney and Sweeney 1984), but they are often able to avoid such conditions by moving into snow interception cover or onto moderately steep southerly slopes. The habitats in which elk concentrate when snow is deep are called "critical winter ranges" because they may be the only areas in which elk can survive severe winters.

In the deep snowpack zone it is extremely important for forage and cover resources to be closely interspersed. Because of their great within-stand variability, and because large trees seem to intercept snow more effectively than small trees, old-growth stands make the best critical winter range in the deep snowpack zone. Old growth on rich, lower-slope sites and floodplains provides critical winter range in many Vancouver Island valleys, but old growth on southerly slopes is also valuable. In the Sayward Forest near Campbell River, where old growth is scarce, south-facing slopes with mixtures of small openings and young-growth forests that provide open snow interception cover (60-70% canopy closure) are the preferred habitats when snowpacks are present during mild and moderately severe winters (Brunt *et al.* 1989).

Security cover remains an important concern in both the moderate and deep zones, while thermal cover becomes more important the farther inland and the higher in elevation the winter range occurs. Often areas of snow interception cover, particularly if composed of old-growth forest, will satisfy needs for security and thermal cover as well.

Very deep snowpack zone

Winter range requirements are not a concern in the very deep snowpack zone because heavy snowfalls result in deep snowpacks during virtually every winter. No elk winter in the very deep zone.

Spring Range

At the end of winter, elk are in the worst condition of the year because they have depleted most or all of their body reserves, the proportion depending on the severity of the winter and the quality of winter range available (Figure 55). Most elk that die from winter mortality do so in the late winter or very early spring before the first flush of new plant growth appears. The sooner the animals can obtain substantial amounts of nutritious forage, the better their chances of surviving for another year. Abundant, high-quality forage is thus the key feature of spring ranges.

Nutritious spring forage is particularly important for pregnant females because they must not only replenish their own bodily reserves but must also meet the nutrient demands of a rapidly growing fetus. Pregnant females that can find only small amounts of food or poor-quality food give birth to small calves which have poorer chances of survival than larger ones (Thorne *et al.* 1976). High-quality spring range is especially important to elk that winter in the deep snowpack zone, as their condition at the beginning of spring is usually poorer than that of elk wintering in the shallow and moderate zones.

No spring range is found in the very deep zone because of its deep snowpack. Elsewhere, the best spring ranges occur where topographic and vegetative conditions promote the early loss of the winter snowpack and the subsequent early flush of plant growth. The same topographic features that enhance winter range values — moderately steep, south-aspect slopes at low elevations, with rock outcrops interspersed throughout — also favour spring ranges (Figure 68). Snow melts most quickly and plant growth begins first in open areas, so spring forage production can be enhanced in areas of favourable slope and aspect by providing open clearcuts with communities of grasses, forbs, and shrubs. The best spring forage is produced by the same understory types that provide the best winter forage (Figure 67). Forage production in forest stands which are not yet ready for harvesting can be enhanced if the stands are thinned to provide wide tree spacing, given that elk forage species are reasonably abundant in the understory before thinning. Elk also forage in other relatively open sites such as wetlands, rich riparian stands, deciduous stands, vegetated slides (when snow conditions permit it), and rock outcrops during spring.

Figure 68. Small openings on southerly slopes often provide good spring range.

As on all seasonal ranges, security cover is extremely important near foraging areas. Once the leaves flush on deciduous trees and understory vegetation, many stands that did not provide adequate visual screening during winter will be suitable as spring security cover.

Elk use thermal cover on spring ranges as shelter from the cold, wet, and windy weather conditions that commonly occur. They shed their winter coats at that time to grow less-insulative summer coats, and are less able to withstand inclement weather. Because they are in such poor condition in early spring, any extra amount of energy expended for thermoregulation may be enough to kill some animals.

Summer Range

Although elk are usually found on summer ranges from April to November, the timing of their arrival and departure may be either delayed or advanced by the timing of snow melt in the spring or the first snowfalls in the autumn. The summer season is an important stage in the annual cycle of all elk, but for different reasons for the different segments of the population. Most calves are born on the summer range, and need high-quality forage and good cover to ensure their survival during the vulnerable first weeks of life and to promote rapid growth and fattening before winter. Mature cows require high-quality summer range to first meet the nutritional demands of the unborn calf during May, and then to produce milk for several months after it is born. Cows also need to build up body reserves that were depleted during the previous winter, so as to optimize their chances of successfully conceiving in the fall and carrying both themselves and a fetus through the coming winter. Adult bulls must replace depleted body reserves, grow a new set of antlers, and build fat reserves to be used during the fall rut and subsequent winter. Other than the Skunk cabbage understory type which is of only moderate forage value during summer, the best understory types are the same as those for other seasons (Figure 67). High-elevation areas in the deep and very deep snowpack zones provide the best summer ranges (Figure 69) because of several favourable effects of mountainous topography:

1. The variety of aspects and the wide range of elevations result in lush, rapidly growing forage remaining available throughout the season;
2. Cool north-aspect (290-70°) slopes allow elk to escape from excessive heat; and
3. Vegetated slide complexes supply abundant, high-quality forage, interspersed with security cover provided by Sitka alders

Figure 69. Headwater areas of Vancouver Island rivers are the summer ranges for many elk herds.

> (*Alnus sinuata*), and cool winds from remnant snowpacks come down avalanche chutes above the slides to reduce the costs of thermoregulation and provide relief from biting insects during summer.

Other important forage areas on summer ranges in the deep and very deep snowpack zones include wetlands, riparian areas, open deciduous stands, and clearcuts.

In the shallow and moderate snowpack zones, moist and wet habitats (wetlands and riparian types) are especially important because the warm, dry summers desiccate forage on upland sites early in the season. Relatively small numbers of resident elk spend the summer in the shallow and moderate zones.

Security cover adjacent to open foraging areas is as important on summer ranges as it is on all seasonal ranges. The topographic variability typical of most high-quality summer ranges reduces the requirement for vegetative security cover, however, because topographic breaks often act as visual screens between foraging areas and roads.

Elk spending the summer in the shallow snowpack zone are most likely to use thermal cover to gain protection from high temperatures, but those on high-elevation summer ranges will use thermal cover during both hot weather and cool, wet, and windy conditions. Old-growth forests provide excellent thermal cover on summer ranges because the multi-layered canopies in these stands reduce temperature, wind speed, and rain throughfall. Dense younger forests are suitable as well, and topographic characteristics can also reduce the effects of excessive temperatures. For example, shade can be found on north-aspect slopes through much of the day, and cooling breezes often occur on exposed ridges.

Calving areas

Most migratory elk calve on their summer ranges unless a lingering snowpack delays spring migration. Calves are very vulnerable to predation during their first weeks of life, so cows move away from the highly visible groups with which they normally associate to seek a secluded area shortly before giving birth. Calving takes place in a variety of habitats that provide good forage and security cover within small areas. Forage and cover must be very close together because cows and their newborn calves usually remain within an area of 1 ha or less before rejoining groups. Most calving occurs on small, flat areas among steeper terrain. Such spots provide good vantage points for detection of approaching predators. Small water bodies or riparian pockets are often associated with these sites. Understory vegetation, logs, tree boles and lower branches, and topographic breaks all enhance the security cover characteristics of a calving area.

Cows tend to use the same calving sites repeatedly in successive years. Because any disturbance of the young calf may lead to its death, **human activity is best avoided near known calving sites from mid-May to mid-July**.

SUMMARY OF IMPORTANT HABITAT FEATURES

Elk concentrate near boundaries between forested and non-forested communities, and adequate interspersion of forage and cover areas is a critical feature of all seasonal ranges. Elk use of seasonal ranges will be high if a forage/cover edge is maintained within 200 m of any point in the range, but openings will receive maximum use if they are no more than 80 m wide. Exceptions to this general rule-of-thumb include stands which satisfy both forage and cover requirements. For example, those with deciduous overstories often provide both abundant forage and adequate security cover. Also, the diverse structure and composition of old-growth communities usually provide forage, security cover, and thermal cover, as well as satisfying snow interception requirements on winter ranges. Cover requirements, including thermal cover on all seasonal ranges and snow interception cover on winter ranges, are best satisfied when the individual stands supplying these characteristics are evenly distributed throughout the seasonal range.

Previous sections outlined how elk requirements vary with seasons and snowpack zones. The following summarizes the key habitat features of seasonal ranges:

1. Winter range, deep snowpack zone:
   - topographic features that reduce snowpacks
   - rock outcrops with forage on south-facing slopes
   - small openings scattered throughout the winter range
   - snow interception cover on floodplains and southerly slopes (old growth is best, but managed stands on south slopes may be suitable)
   - security cover and thermal cover near forage areas
   - good interspersion of forage and cover areas.
2. Winter range, moderate snowpack zone:
   - topographic features that reduce snowpacks
   - rock outcrops with forage on south-facing slopes
   - open-canopied foraging areas (more important than on winter ranges in the deep snowpack zone)
   - snow interception cover on floodplains and southerly slopes (old-growth forests provide optimal conditions, but in most instances managed young-growth will suffice)
   - thermal cover and security cover near forage areas.
3. Winter range, shallow snowpack zone:
   - small openings (especially wetlands and rock outcrops) and open forests (especially deciduous, riparian, and old-growth stands) for foraging
   - security cover near forage
   - some closed-canopy thermal cover.
4. Spring range:
   - topographic features that enhance rapid snow melt and early growth of forage
   - openings or open-canopied stands on south-facing slopes
   - other areas capable of producing abundant, preferred forage including wetlands, riparian areas, vegetated slides, and deciduous stands
   - security cover and thermal cover near foraging areas.
5. Summer range:
   - topographic features (a range of elevation and a variety of aspects) providing forage at various stages of phenological development
   - northerly slopes (290-070°) where heat stress is minimized
   - forage areas with lush vegetation (vegetated slides, wetlands, riparian stands, deciduous stands, clearcuts)
   - patches of security and thermal cover.
6. Calving areas:
   - small, flat areas among steeper terrain where abundant forage is finely interspersed with good security cover (especially when associated with small pockets of water or riparian habitat).

Chapter 4

Interactions of Timber Management with Deer and Elk

by
J.B. Nyberg

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INTRODUCTION

This chapter describes how deer and elk are affected by the management of coastal forests for timber production, and how management of the animals and their habitats affects timber management. It begins with a discussion of the key habitat issues for deer and elk in coastal forests, then evaluates the effects of individual forestry practices, and closes with a discussion of the impacts of deer and elk on forestry.

KEY HABITAT MANAGEMENT ISSUES

The major impact of forestry on deer and elk management is the loss of opportunities for hunting and appreciative uses caused by logging and silvicultural programs that degrade wildlife habitat. The great majority of the habitat protection and management requests that the Ministry of Environment makes of the Forest Service and forest companies centre around a small group of issues. These issues are the provision of:

1. winter range for both deer and elk;
2. spring range for deer;
3. cover along roads to screen elk from view and from disturbance by traffic; and
4. cover for deer and elk adjacent to recently clearcut areas and other open foraging areas.

Biologists emphasize these issues because they are considered to be the most critical in determining the capability of habitat to support the animals. The reasons these issues are important to the welfare of deer and elk populations were explained more fully in Chapters 2 and 3; this section briefly summarizes the concerns and the typical management actions taken.

Winter Ranges

"Critical winter range" is a term used in coastal British Columbia to mean forested habitat, usually stands of mature or old-growth conifers, that provide deer and elk with resources critical to survival during severe winters. We use that definition here. Such habitat is often used by large numbers of animals when snow is more than approximately 30 cm deep in the open. In this book, the simpler term "winter range" implies the entire area used by one or more animals during the whole winter, and typically encompasses a much greater area than the critical winter range.

Heterogeneous stands of old trees make the best critical winter ranges because they provide the optimum combination of characteristics that intercept snow and supply forage in the form of shrubs, herbs, and arboreal lichen litterfall (Bunnell 1985). Critical winter ranges of deer usually occur on south-facing slopes at moderate to low elevations; critical winter ranges of elk occur on both southerly slopes and rich, moist sites elsewhere (Figure 70).

Because of different logging histories, site productivity, and availability of mature timber, the two Ministry of Environment regions on the south coast have used somewhat different criteria for designating critical winter ranges for deer when reviewing logging plans. In the Vancouver Island Region, certain Douglas-fir and western hemlock stands 250 years and older have been deferred from logging. The preferred size of individual ranges has been 20 ha or more, usually separated by no more than 4 km in watersheds where deer management is a priority (D.C. Morrison, B.C. Ministry of Environment, pers. comm.). Although up to 10% of the forested land base is thought to be required as critical range to sustain deer at "natural" levels through severe winters,[9] logging and the distribution of suitable forest cover types have limited the amount actually designated to less than 6%, even in the highest priority watersheds. In the Lower Mainland Region, much younger stands have been considered to suffice as critical winter range. Providing the overstory was dominated by Douglas-fir and there was an abundant understory of shrubs, stands 100 years and older could be designated as critical. The same topographic criteria define critical winter range sites in both regions (Figure 71).

Where elk occur on northern and western Vancouver Island, their most heavily used winter ranges are often stands of old-growth western hemlock and Sitka spruce on river floodplains. Recommendations for designation of critical winter ranges for deferral from logging in these areas are usually based on field surveys of elk use and habitat suitability, and no quantitative criteria for the size and distribution of these ranges have yet

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[9] Ministry of Environment and Ministry of Forests. 1983. Reservation of old growth timber for the protection of wildlife habitat on northern Vancouver Island. Victoria, B.C. Unpubl. report. 62 p.

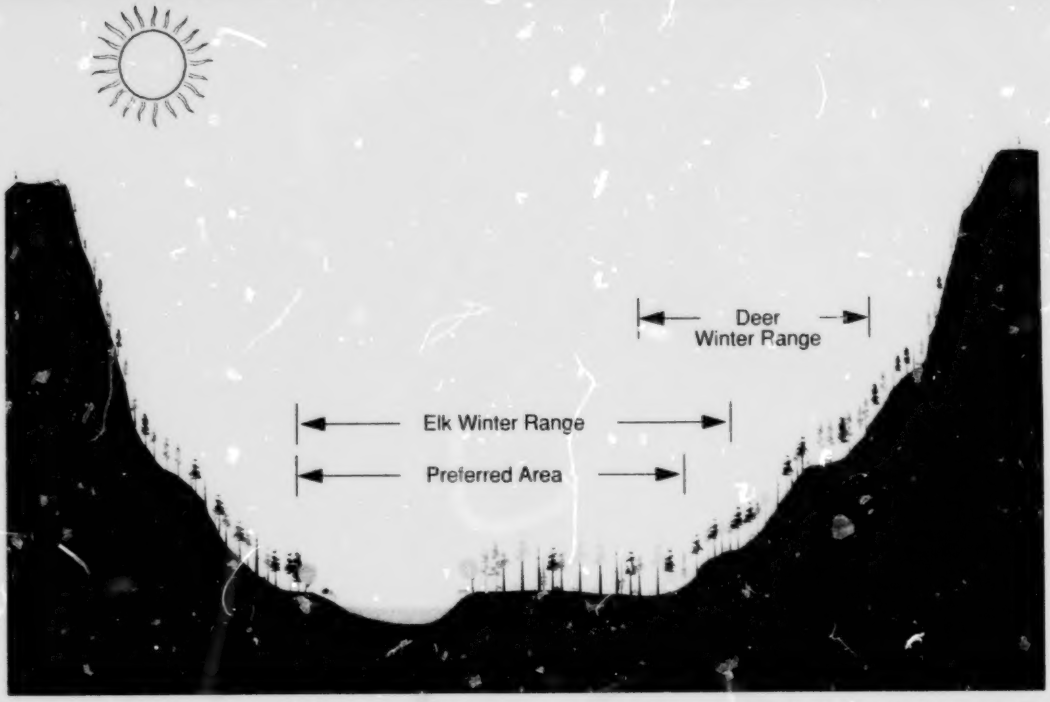
Deer
Winter Range
Elk Winter Range
Preferred Area

Figure 70. Many elk and deer concentrate in old-growth forests on valley bottoms and southerly slopes during severe winters.

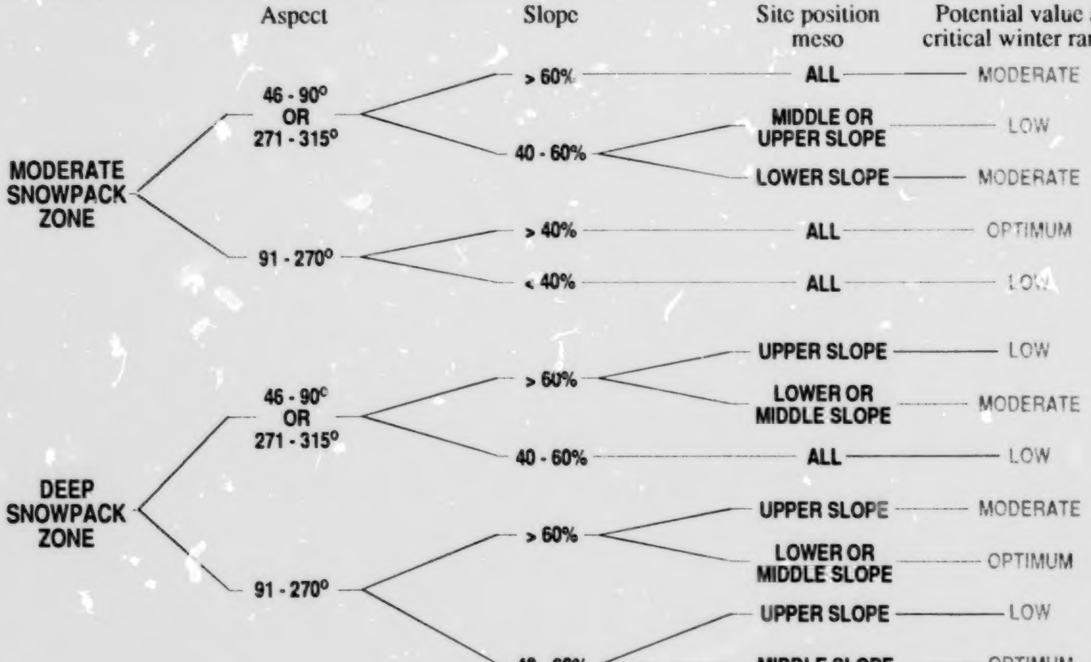
Aspect
Slope
Site position
meso
Potential value as
critical winter range
MODERATE
SNOWPACK
ZONE
46 - 90°
OR
271 - 315°
> 60%
ALL
MODERATE
40 - 60%
MIDDLE OR
UPPER SLOPE
LOW
LOWER SLOPE
MODERATE
91 - 270°
> 40%
ALL
OPTIMUM
< 40%
ALL
LOW
DEEP
SNOWPACK
ZONE
46 - 90°
OR
271 - 315°
> 60%
UPPER SLOPE
LOW
LOWER OR
MIDDLE SLOPE
MODERATE
40 - 60%
ALL
LOW
91 - 270°
> 60%
UPPER SLOPE
MODERATE
LOWER OR
MIDDLE SLOPE
OPTIMUM
40 - 60%
UPPER SLOPE
LOW
MIDDLE SLOPE
OPTIMUM
LOWER SLOPE
MODERATE

Figure 71. Topography influences the potential value of sites below 1000 m elevation as critical winter ranges for deer and as spring ranges for deer and elk. Elevations above 1000 m and all combinations of aspect, site position, and slope other than those shown above are generally unsuitable. Ratings were derived from Ministry of Environment surveys (R. Davies and R.D. Forbes, unpublished data). Site positions are defined by Luttmerding et al. *(1990).*

been developed (I. McDougall, B.C. Ministry of Environment, pers. comm.). Elk winter ranges usually occupy a very small proportion of the forested land base. Because they often support high volumes of valuable timber, however, their potential contribution to the timber harvest is higher than their total area would suggest.

Spring Range for Deer

During cold, snowy winters, deer expend extra energy in moving through snow, while taking in less energy from forage than is normal. By the time spring arrives, they may be near death from starvation. At such times it is critical for them to obtain highly nutritious food as soon as possible. Lush new growth from grasses, other herbs, and shrubs can provide the nutrients they need, but deer often cannot or will not travel far to reach it. Consequently, good quality spring range is needed close to critical winter ranges.

One of the measures commonly requested by the Ministry of Environment to provide spring forage near areas of heavy winter deer concentrations (especially old-growth winter ranges) has been called "rotational logging." This system delays logging of successive blocks of timber around designated winter ranges ("rotates" them). It ensures, for 40 years or more, continuous production of the early successional vegetation that is typically found in clearcut areas during the first 10-15 years after logging (Figure 72).

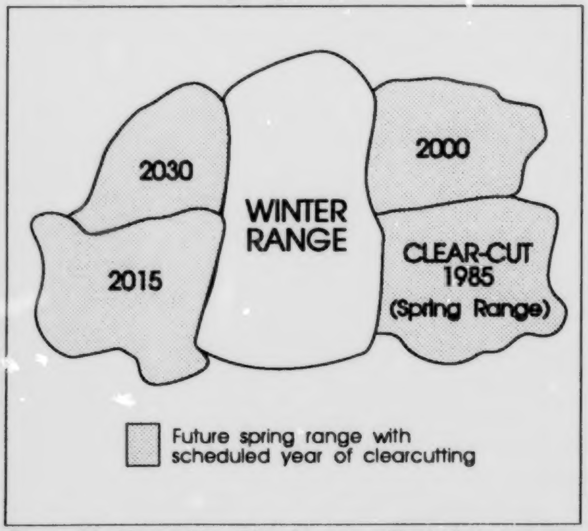
2030
2000
WINTER RANGE
2015
CLEAR-CUT 1985 (Spring Range)
Future spring range with scheduled year of clearcutting

Figure 72. Harvesting of blocks near critical winter ranges may be spread over many years to sustain long-term production of spring forage.

In the last few years, there has been increasing interest in the possibility of maintaining spring forage in young forest stands by using thinning to keep tree density relatively low. This approach, discussed more fully in Chapter 5, offers a promising alternative to rotational logging. Through more intensive management of the stand on a single site near each winter range, many of the road maintenance and harvest scheduling problems associated with rotational logging can be avoided.

Visual Screens and Cover for Elk

Because of their herding behaviour and tendency to use preferred habitats (wetlands, riparian areas, vegetated slides) for long periods, elk are especially susceptible to shooting and harassment by humans. Both legal hunting and poaching are aided by situations in which vegetated cover on roadsides is removed adjacent to areas where elk congregate seasonally. In addition, substantial evidence from the United States indicates that elk use decreases near roads and throughout areas that have a high density of roads (Lyon 1983; Witmer and deCalesta 1985). Biologists commonly seek to lessen disturbance and mortality of elk herds by maintaining visual screens of vegetation along roadsides near preferred habitats, or surrounding the habitat entirely to give abundant security cover.

Visual screens can be provided by vegetation or topography that block views from the road. (Figure 73).

Cover Adjacent to Clearcuts and Other Open Foraging Areas

Deer make extensive use of logged areas for feeding except when snow is deep and soft. Much of the use occurs at night where human disturbance is common, especially during hunting season. Many studies have documented a trend to decreasing use as distance from vegetative cover increases (e.g., Willms 1971; Hanley 1983). Elk on Vancouver Island use clearcuts less than deer do, but often forage in natural openings such as wetlands, riparian sites, and vegetated slides. Like deer, elk also make heaviest use of areas near cover (Figure 62, p. 88). Thus, the value of an open foraging area for deer and elk habitat will be higher if the logged area is kept narrow and sufficient "green-up" (growth of young conifers) has occurred in adjacent units to provide security cover close at hand.

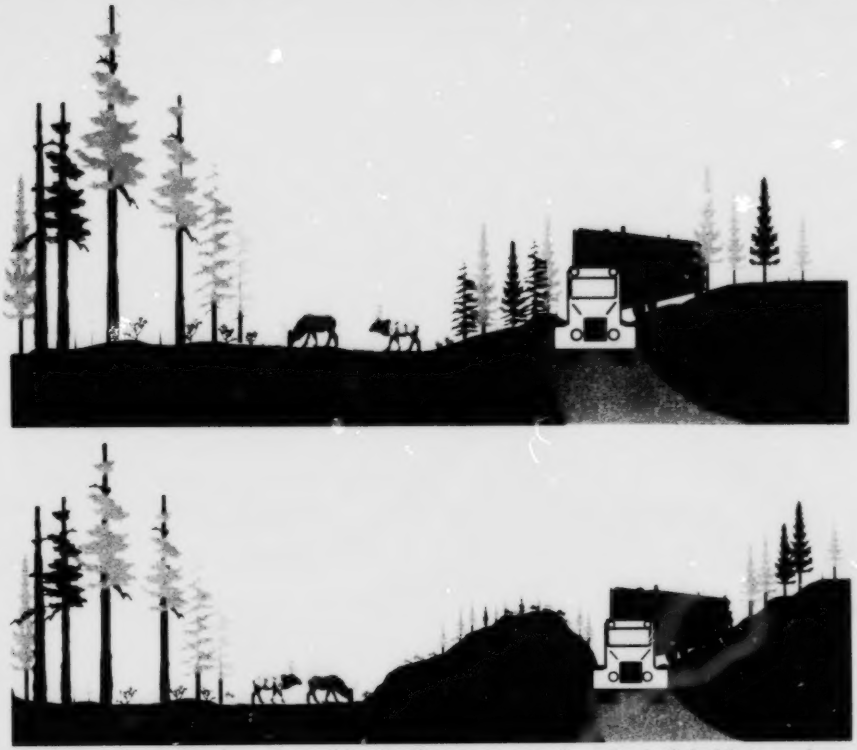

Figure 73. Both vegetation and topography can provide visual screens near important elk habitats such as wetlands.

The Ministry of Environment has set no firm criteria for the overall size or width of clearcuts, but has asked that they be kept smaller than 80 ha whenever feasible. As Figure 74 shows, however, openings would need to be less than 120 m wide to maximize deer and elk use.

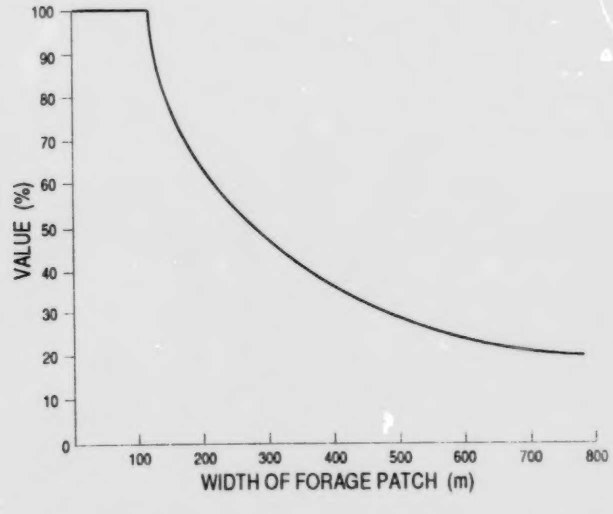

Figure 74. The value of clearcuts (average use per unit area) as foraging areas for deer and elk declines as clearcut width increases beyond 120 m. Derived from radio-telemetry data for deer (R.S. McNay and D.D. Doyle, unpublished data summarized by L.L. Kremsater) and elk (Brunt et al. 1989) in areas of mixed openings and forest cover.

Standards for green-up as applied by Ministry of Environment habitat protection staff usually call for establishment of a well-stocked stand of conifers 2 m tall (for deer) or 3 m tall (for elk) before adjacent areas are logged, at least where deer or elk habitat management is a moderate to high priority. Patches of security cover must be wider than roadside screens to be fully effective (Figure 75), because security cover must provide an internal area screened by vegetation from all sides. Although data for deer on Vancouver Island show no decrease in cover use near the edge of patches of security cover (Figure 62, p. 88), few patches less than 100 m wide were sampled. Data for Vancouver Island elk (Figure 62, p. 88) and evidence from elsewhere for deer (Thomas *et al.* 1979) suggest that security cover patches should be at least 100 m wide to satisfy both species.

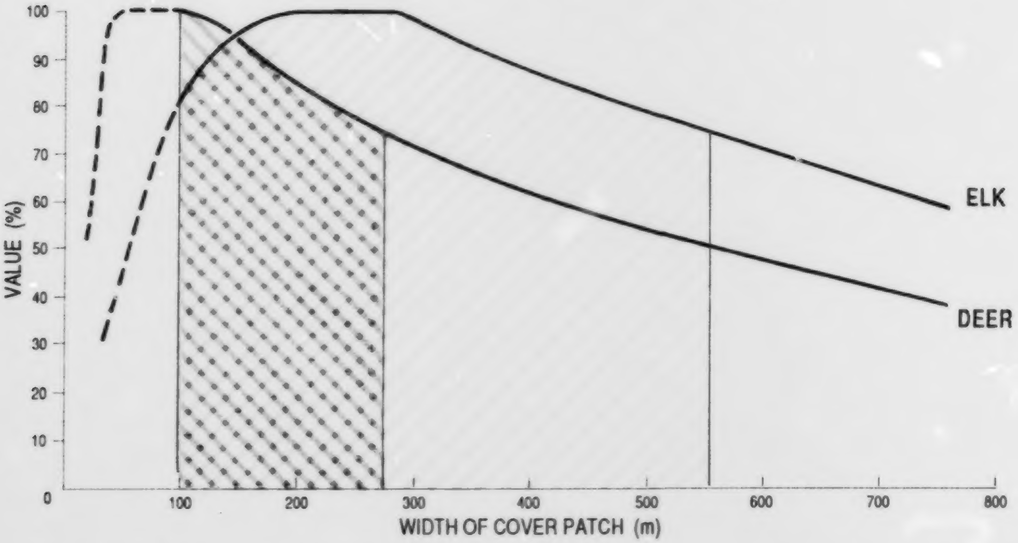

Figure 75. Security cover patches approximately 100-300 and 100-500 m wide provide optimum value for deer and elk, respectively. The dashed lines below 100 m width indicate uncertainty about minimum effective sizes of cover patches. Derived from radio-telemetry data for deer (R.S. McNay and D.D. Doyle, unpublished data summarized by L.L. Kremsater) and elk (Brunt et al. *1989) in areas of mixed openings and forest cover.*

IMPACTS OF TIMBER MANAGEMENT ON DEER, ELK, AND HABITAT

Timber management affects deer and elk in several ways: by disturbing animals living near active forestry operations; by providing hunters with good road access; and by changing the structure and composition of forested habitats. Although the direct effects of disturbance and shooting on animals are more obvious than the indirect impacts caused by habitat change, it is habitat alteration that concerns wildlife managers most.

Forestry activities such as logging and prescribed burning have drastically changed habitats over most of the south coast. In the 1987-88 fiscal year alone, for example, 48500 ha were harvested and 72000 ha silviculturally treated in the Vancouver Forest Region (B.C. Ministry of Forests and Lands 1988). Some activities, such as clear-cutting, have major and long-lasting impacts (both beneficial and detrimental) on habitat. Others, like fertilization, have small and short-lived effects. All of these impacts on vegetation ultimately influence deer and elk as well, by changing the quality and spatial patterns of their habitats. Whether the impacts are favourable or not depends on many factors, including the nature of the forestry treatments, their timing and locations, the sizes of the areas treated, and the composition of surrounding habitats.

The coastal forests of British Columbia are in transition from a time when they were largely mature or old growth, unaffected by man and with a small component of young forest generated by natural disturbances, to a future state in which much younger, managed stands established after logging will be most common. Young forests already dominate the landscape in many low-elevation areas. To improve the quality and increase the growth rates of these younger stands, foresters are applying many new practices that were virtually unused in British Columbia before about 1970. These practices occur at intervals throughout the life of a stand (the rotation), which is projected to be 50-100 years for most coastal forests managed primarily for timber production.

Three phases of forestry activity take place over a rotation in most managed stands: harvesting, regeneration, and stand tending (Figure 76). Because most coastal sites support old-growth stands (or did so before logging occurred), harvesting is usually the first activity that takes place.

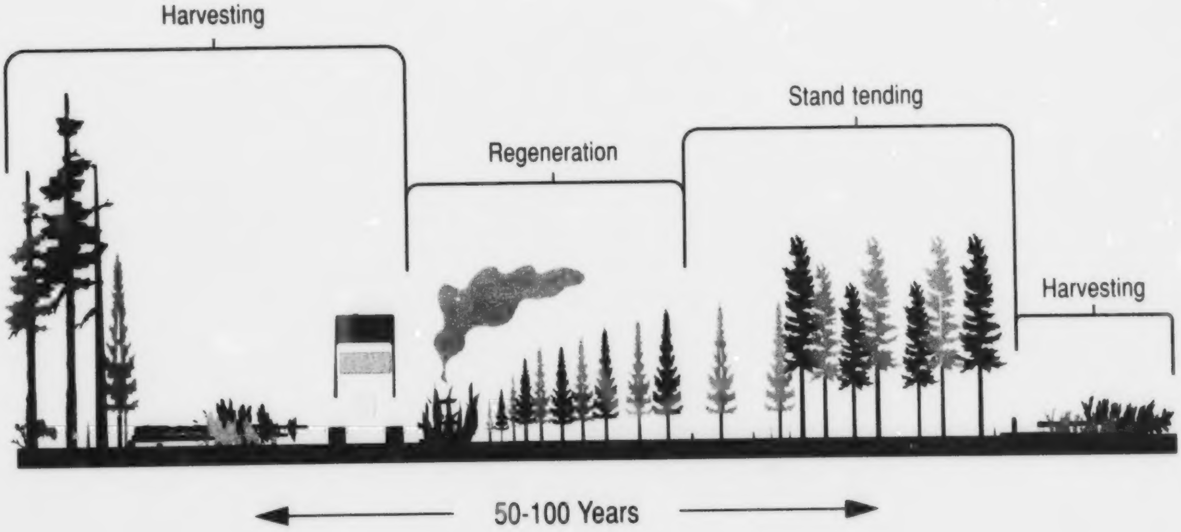

Figure 76. Phases of forestry activities through the rotation.

The **harvesting** phase begins with a pre-harvest assessment of the condition of the stand and the site, the pre-harvest silvicultural prescription (PHSP). When preparing a PHSP, a forester considers appropriate harvesting, site preparation, and regeneration techniques, and potential impacts on other resource uses, including wildlife. After new access roads are constructed or existing ones are improved, the stand is harvested, usually by clearcutting. Partial ("selective") cutting is used on a small proportion of coastal sites (3% of the area harvested in 1987-88).

The **regeneration** phase normally begins after the last of the merchantable logs are removed from the clearcut site. During this phase, the site may be prepared for the new crop by broadcast or spot burning of slash, by mechanical scarification, or by control of competing vegetation through weeding and cleaning (brushing and weeding). In many cases, no site preparation is required, particularly if slash loads are light, the soil is thin, or the new crop species regenerates best in organic rather than mineral soil. The regeneration phase ends when the new crop is established through planting, natural seeding from trees nearby, or release of advance regeneration.

Once the new stand is established, **stand tending** begins. Activities such as weeding and cleaning, fertilizing, non-commercial thinning (juvenile spacing), and commercial thinning are commonly applied in intensively managed forests. Other stands, particularly those on poorer sites or in inaccessible areas, may receive no treatment at all between the regeneration and harvesting phases.

Whether managed or unmanaged, the natural succession of vegetation and growth of trees produce gradual changes to a stand and its understory vegetation. These changes interact with the more sudden variations imposed by forestry treatments to create a dynamic and diverse pattern of wildlife habitats across the landscape.

Effects of Individual Forestry Activities

In this section, the effects of the most important coastal forestry activities on deer, elk, and habitat are described. Each section begins with a description of the nature of the activity and of the time during the rotation period when it is used. This is followed by a discussion of impacts on animals and habitat, the most important of which are summarized on pages 121 and 122. Data on the amount of area affected by the forestry activities are 5-year averages for the Vancouver Forest Region drawn from Ministry of Forests annual reports for fiscal years 1983-84 through 1987-88 (B.C. Ministry of Forests 1984, 1985; B.C. Ministry of Forests and Lands 1986, 1987, 1988) and are rounded off for simplicity.

Because the effects of forestry are so varied, all the influences on deer and elk are not discussed in detail. Instead, discussion is focussed on impacts that are potentially important enough to concern wildlife and forest managers. These are treated in several simple categories that relate to deer requirements: forage, cover, and access (ability of animals to move through forests).

The descriptions of the effects of individual treatments are not intended to obscure the importance of time and space in determining overall habitat quality. Individual **activities** make up parts of a management **regime** that may extend for 80 years or more, and the timing and sequence of treatments are as important as the nature of each activity. Also, animals exploit more than one stand in meeting their necessities of life. The value of any habitat component in one stand may be affected by what is available in adjacent or nearby stands. In considering these implications of time and space, the assessment of stand and site conditions for the **PHSP** provides an ideal opportunity to evaluate some of the key determinants of the habitat quality of the stand to be established after logging. For example, the composition of the understory vegetation present before logging gives valuable clues to the forage complex that will be produced after burning or thinning; the presence of rock outcrops or root-rot infections may provide small openings or different understory communities; and areas of dense hemlock seedlings may indicate patches of future thermal or security cover that should be protected from prescribed fire. By noting these and other site and stand characteristics in the field before logging, managers can maximize their options for producing both timber and wildlife habitat. They can then select from the following activities to attain their objectives.

Roads and hauling

Forest roads in coastal British Columbia range from paved mainlines used by many vehicles daily for years, to temporary spurs used only by heavy equipment during a short period of logging. The density, standard, and condition of roads vary greatly, depending on the nature and timing of logging and forestry treatments. The factors of highest concern for deer and elk, however, are few: road density (thus the distance between roads), the frequency of traffic, the nature of vegetation on the right-of-way, and the duration of use.

Deer and elk often walk along roads and feed on roadside vegetation, particularly where adjacent cover or logging debris is dense. Black-tailed deer are fairly tolerant of humans and of light vehicle traffic, especially during the closed hunting season. If little cover is available next to the road and if traffic is heavy, however, deer will avoid roads. Preferred feeding areas near roads are often used only at night in these circumstances.

In the western United States, elk are considered to be sensitive to human disturbance, and road density per unit area is one of the key factors determining habitat quality (Thomas *et al.* 1979; Lyon 1983; Witmer and deCalesta 1985). On Vancouver Island, however, elk use in forested habitats appears to be less affected by roads. During the IWIFR study of elk in the Sayward Forest-Salmon River area, some of the study animals were observed using a bog that was within 100 m of an actively travelled road but concealed by a strip of forest. Most elk use in forested winter habitats (with adequate security cover) was within 200 m of roads (Brunt *et al.* 1989). In open areas such as clearcuts and deciduous stands lacking security cover, though, elk use was noticeably affected by roads. And on summer range, clearcuts were used most often from dusk through dawn, when there was little or no vehicle traffic. Ninety-five percent of that use occurred within 200 m of forest.

On winter range, clearcuts were rarely used. It was not clear, however, whether this was due to disturbance or other factors. The little winter use of clearcuts that was observed usually occurred within 200 m of forests. Habitats that were normally highly preferred, such as bogs and seepage sites, were rarely used if they were clearly visible from a road. These findings lend support to the management emphasis on visual screens and roadside cover as key habitat issues for elk.

Besides easy access, another factor that attracts deer and elk to roads is the roadside vegetation. Because of the disturbance associated with road construction, vegetation communities on roadside rights-of-way are often dominated by grasses, forbs, and young shrubs. On older roads traversing densely forested areas, these communities are often the only early successional vegetation available for some distance. Also, the exposure of the road verge to direct sunlight encourages the early growth of vegetation in the spring. Thus, nutritious forage draws many deer early in the growing season because plants in other areas have not yet flushed. The practice of seeding roadsides with erosion-controlling ground covers of grasses and other herbs is increasingly common on highways and forest main lines, and will provide valuable spring forage in areas where dense forests dominate. This benefit must be weighed against the increased likelihood of roadside collisions and the greater potential incidence of illegal harvest.

When vehicle use ceases completely, gravel roads often regenerate to deciduous species such as red alder. The amount of roadside forage then declines gradually as a deciduous overstory develops. The invading vegetation on the old road surface, however, provides some forage variety as the surrounding coniferous forest grows.

Elk, because of their greater sensitivity to disturbance, do not use vegetation on the sides of active roads for foraging as extensively as deer. Once roads fall into disrepair, particularly if deciduous trees grow up, both travel and feeding by elk become more common.

In recent years, as illegal killing has taken a heavy toll of south Island elk herds, the negative aspect of logging roads in providing easy human access has become apparent. Without roads, both elk and deer would be much safer from poaching, but legitimate hunting and viewing use would also be much more difficult. Road closures may become necessary in areas with severe poaching problems if adequate enforcement of wildlife regulations is not possible.

Logging

More than 95% of coastal logging involves clearcutting. The vast majority of coastal trees are felled with chainsaws, but use of mechanical feller-bunchers in small timber is increasing slowly. Mechanized cutting is expected to further increase in importance as harvesting shifts from old-growth to younger stands. Both overhead cable yarding and ground skidding are widely used at present, with skidders usually restricted to slopes less than 30% because of the soil disturbance they cause.

Logging affects deer and elk in three ways:

1. by removing existing cover and forage;
2. by encouraging abundant regrowth of forage after 1 or 2 years; and
3. by increasing the woody debris (slash) on the ground.

At first, cutting of overstory trees and the disturbance caused by yarding reduces cover and forage. Most logged sites have no value as security cover until a new stand grows to at least 2 m high, unless patches of small residual conifers remain uncut. Significant thermal and snow interception cover will develop only after the stand reaches 10 m in height. Loss of cover in the logged area may also affect use of adjacent habitats. As described in the previous section, elk may avoid wetlands and meadows if no cover is available to screen them from road disturbance.

Nevertheless, the reduction of forage caused by logging disturbance is short-lived. By the third growing season following logging, the exposure of the understory to full sun and the cessation of below-ground competition by tree roots lead to an increase in the quantity of forage available (Kellman 1969) (Figure 77). This major flush of

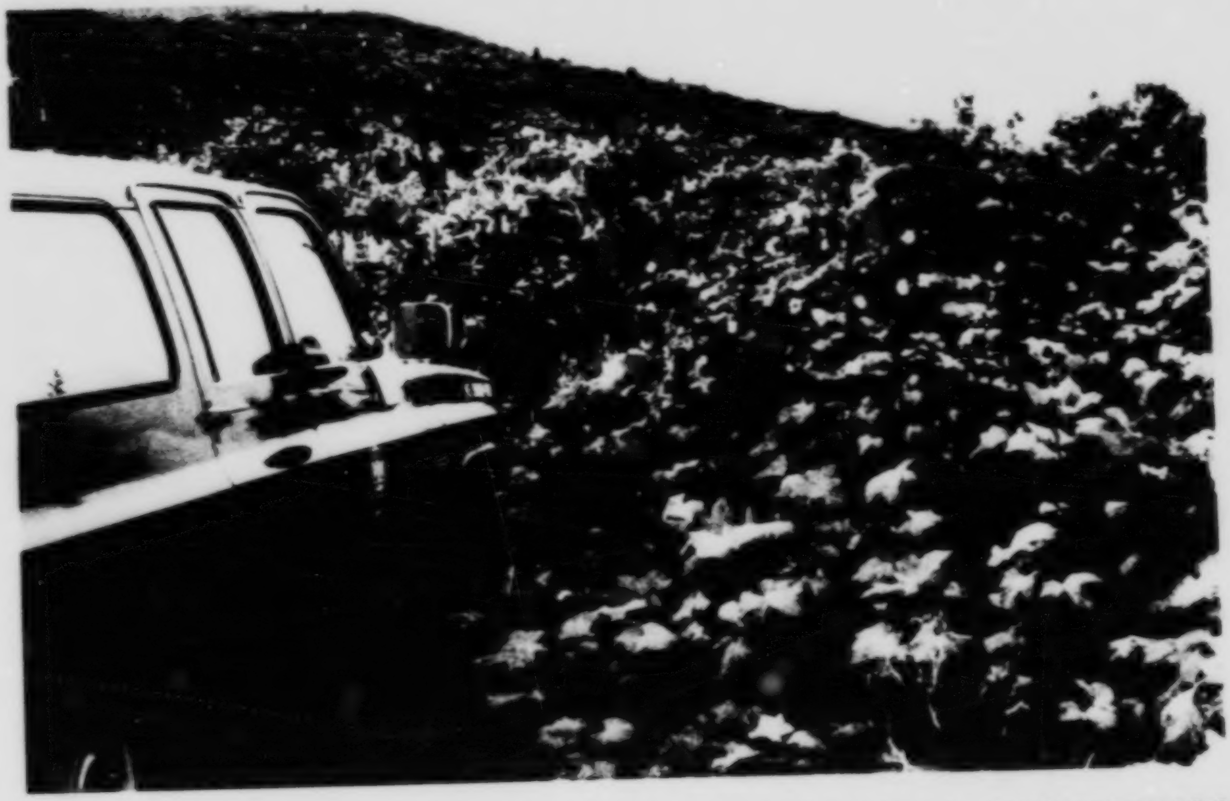

Figure 77. Abundant and diverse communities of herbs and shrubs provide excellent spring and summer forage (especially for deer) in many clearcuts.

vegetation provides as much as 15-20 years of valuable forage in clearcuts. Also, the composition of the understory on logged sites usually shifts as pioneer plant species invade freshly exposed soil in full sunlight. Subsequent site preparation activities such as slashburning often enhance the species shift. This change of understory composition produces more spring and summer forage, especially herbs such as fireweed. Sometimes shrubs, which form the bulk of the winter forage supply, decline significantly.

The pattern of logging is important in determining deer and elk use of increased forage because both species prefer to remain near cover when feeding. Most use of openings occurs within 200 m of the forested edge, so the centre portions of clearcuts wider than 400 m will receive little use until cover grows.

Finally, logging leaves slash on the site. This debris may, depending on its depth and density, pose a serious barrier to deer and elk use by preventing or discouraging them from moving through the logged area. The debris problem is most severe in old-growth stands of hemlock and western redcedar because of the high proportions of non-merchantable wood and frequent breakage or shattering of felled trees. Slash is usually a minor concern when mature and old-growth Douglas-fir is being logged. Slash less than 30 cm high has little effect on deer unless it covers more than 50% of the ground, but at slash depths greater than 30 cm, deer expend large amounts of extra energy in moving about because they must jump over obstacles (Parker *et al.* 1984). These energy costs increase most dramatically when more than 10 obstacles greater than 30 cm high must be cleared in every 100 m of travel (Figure 78). Because of their longer legs, elk can more easily negotiate greater debris depths, but the extra energy costs as debris becomes denser are still dramatic. The model employed by Parker *et al.* (1984) predicts energy expenditure of elk walking through debris 80 cm high at a density of 25 obstacles per 100 m to be about 5 times greater than through debris of the same density but half the height.

Extremely heavy debris loads can also limit long-term vegetation responses by occupying most of the potential growing sites. Sites with such heavy slash are often broadcast burned.

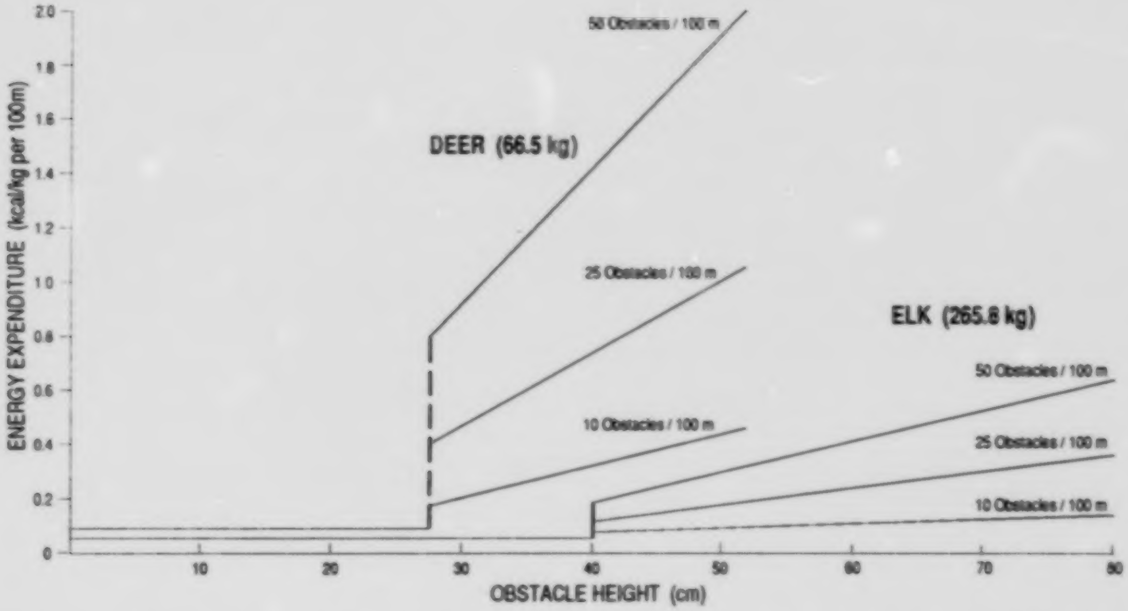

Figure 78. Predicted energy expenditures by deer and elk for locomotion through slash of various densities. Adapted from Figure 1 of Parker et al. *1984.*

Site preparation

Site preparation, the process of preparing logged land for the establishment of a new forest crop, incorporates a number of treatments used to remove slash and vegetation, prepare the soil, and remove hazards to workers. About 30% of clearcut areas on the coast receive some form of site preparation.

By far the most common practice is the use of prescribed fire (Figure 79). Since 1983, from 3800 to 7500 ha have been burned annually in the Vancouver Forest Region, 85% of which was broadcast burned. The remainder was either spot burned or bunched (piled) and burned. Burning serves a number of purposes, the most important of which are to lessen the risk of wildfire, reduce slash to make more sites available for planting, and reduce surface organic horizons. Less commonly, prescribed burning is employed to reduce competition from existing vegetation before trees are planted.

Other forms of site preparation are uncommon on the coast. Mechanical scarification covers less than 600 ha in most years. Residual tree falling and snag falling, which remove trees that were left standing after fire or logging, ranged from 900 to 4000 ha during 1983 to 1988.

Prescribed burning affects deer and elk habitat in a variety of ways, depending on the extent and severity of the fire. Any fire will reduce small debris, thus improving access for animals, but only hot broadcast or spot burns will significantly decrease obstacles such as large logs, stumps, and windrows or piles of slash. The effect of fire on cover is usually of no concern for deer and elk because little or no vegetation cover remains after clearcutting. In areas where extensive openings exist, however, patches of advance regeneration, residual trees, or slash piles may provide valuable cover that is susceptible to loss during broadcast burning.

Responses of deer and elk forage to burning are much more important. The initial effect is a drastic reduction in forage availability as a result of the destruction of above-ground parts of plants persisting after logging. Invading species, such as fireweed, and new growth from the undamaged roots of remnant plants soon appear in abundance (often during the first growing season after burning). The resulting lush and diverse herbaceous vegetation dominates many burned areas for several years after fire, providing spring and summer forage for deer to equal the best found in natural openings. The low albedo (reflective power) of fire-blackened ground further enhances

Figure 79. Broadcast burning is the most commonly used site preparation method on the south coast.

the value of south-facing clearcuts to deer because the soil warms quickly after snow melt, encouraging early plant growth. Because of their diet preferences, elk make less use than deer of post-fire vegetation.

Shrubs sometimes respond less favourably than herbs to fire. Prescribed fires can be so hot that they destroy not only the tops but also the underground tissues of shrubs, resulting in loss of most of the shrub component of the understory. Shrubs are important foods for deer and elk year-round, but are especially critical for deer during winter, when little herbaceous food is available.

Fortunately, shrubs are usually set back for only a few years by fire. The subsequent growth of existing plants, plus the establishment of new ones by seed or vegetative reproduction, eventually provides a more abundant and diverse shrub community than existed before the fire (Schoonmaker and McKee 1988). The combined effects of fire in reducing slash and stimulating forage growth usually provide a 10- to 15-year benefit to forage production.

Scarification effects on deer and elk habitat are minimal. An increase of herbaceous forage on disturbed soil is the only impact of any consequence. Similarly, snag and residual tree falling are of little concern for deer and elk in most cases.[10] In areas of high priority for future deer winter range management, however, the loss of dead and dying trees that provide a potential source of lichens to the new forest could be an important concern. Also, herbicides are commonly employed in site preparation and can have significant negative effects on forage. The effects of these chemicals are discussed later under "Weeding and Cleaning."

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[10] Snags and residual trees may be of great importance to other wildlife species such as cavity-nesting birds and bats.

Regeneration (planting and natural seeding)

Regeneration, the renewal of a tree crop, employs both natural and artificial means in coastal British Columbia. Natural regeneration is commonly used when western or mountain hemlock, western redcedar, or amabilis fir is the desired species. It is often successful on moist coastal sites and accounts for about 30% of the area reforested each year in the Vancouver Forest Region. Natural regeneration is much less successful for Douglas-fir and Sitka spruce, which have irregular cone crops, so artificial regeneration is usually used to establish these species.

All artificial regeneration in coastal British Columbia is by planting (direct seeding is not used in south-coastal British Columbia). Fourteen different species totalling 19-31 million trees were planted annually in the Vancouver Forest Region from 1983 to 1988. About 3 times as many Douglas-fir seedlings were planted as the next most common species (amabilis fir). The usual planting density is approximately 1100 trees per hectare.

Regeneration of trees has both positive and negative effects on deer and elk. The establishment of a coniferous stand can eventually be beneficial because cover will be provided, but it can also be detrimental because forage will be reduced through competition with the trees for growing space, light, water, and nutrients. Short-term effects are minor, consisting only of the small increase in forage abundance and diversity that is provided by newly established trees, some of which are often browsed (see pp. 124-125). Only after a minimum of 5-10 years, as the trees reach several metres in height and the crowns begin to close, do the effects of the new stand become important. With the development of a closed canopy, thermal and snow interception cover begin to form. At the same time, dense lower branches conceal animals well, providing some of the best security cover to be found in any habitat. However, as crowns close, a period of poor forage production begins. This condition may persist for several decades or longer if the stand remains dense.

Variations in density and survival of young trees can greatly alter the interval between stand establishment and the time at which major long-term effects on deer and elk arise. Very dense hemlock stands (>5000 trees per hectare) on productive sites may begin to provide good cover and lose their understories as early as 7 years after tree establishment, but open stands (800-1200 stems per hectare) of Douglas-fir on dry sites may retain patches of good forage for more than 20 years (Nyberg *et al.* 1990a). The densest hemlock stands, which in patches may exceed 100000 stems per hectare, are virtually impassable to deer and elk and receive no use.

Species conversion (site rehabilitation)

Species conversion is an intensive silvicultural practice designed to replace non-commercial trees, such as alder, with conifers. It may employ some or all of the individual practices already discussed, including road construction (to reach the site), logging, site preparation (including burning or herbicide treatments, or both), and regeneration (planting). Because of the high cost of these treatments and the long delay before a cash crop is produced, species conversion has been uncommon to date, being restricted on the coast largely to accessible and highly productive sites occupied by red alder stands. Since 1983, an average of only 800 ha/yr on Crown land have been converted in the Vancouver Forest Region.

Because of the large number of different treatments used in species conversion, the effects on habitat are numerous. Readers interested in detailed effects can refer to the descriptions of each practice on preceding pages. To a large extent, the individual effects on deer and elk eventually cancel each other out because an overstory of one type (deciduous) is replaced with an overstory of another (coniferous). The short-term effects, however, can be important in areas where cover is scarce, because species conversion initially reduces security cover and summer thermal cover.

Effects on forage may initially be beneficial or detrimental, depending on whether herbicides are used and how they are applied. Broadcast application of glyphosate or 2,4-D to control salmonberry or other shrubs may seriously reduce elk habitat quality, but spot treatments of shrub patches or of small areas around planted seedlings may leave abundant forage elsewhere on the site. Long-term cumulative effects of species conversion are sometimes of concern because stands of large alders provide habitat diversity and a rich herbaceous understory in landscapes dominated by dense, uniform coniferous stands with little forage (portions of the Sayward Forest, for example). This is especially important for elk, because deciduous and mixed deciduous-coniferous stands are highly preferred foraging areas (Brunt *et al.* 1989) (Figure 80).

Figure 80. On rich sites, elk use deciduous stands heavily for foraging.

Weeding and cleaning (vegetation management)

This section deals with activities that attempt to control or suppress vegetation competing with young forest crops, including "brushing and weeding" and "conifer release" (the killing of overstory hardwoods to release understory conifers from competition). All of these operations have the same purpose — to establish a fast-growing crop by reducing competition from non-commercial species — and have similar effects on deer and elk habitat.

The extent of weeding and cleaning activities has increased dramatically in recent years. From 3000 ha of Crown land in the Vancouver Forest Region during the 1981-82 fiscal year, the program expanded to about 12 000 ha each year after 1984-85. With the increase in total area treated, there was a corresponding increase in the proportion of the area that was treated with herbicides: from 28% in 1981-82 to 75% in 1985-86. The amount of area cleaned and weeded by hand grew much more slowly.

Of the more than 20 herbicides registered in British Columbia for use in nurseries, on roadsides, and on public forest lands, only two are commonly used on the coast (Table 8). Glyphosate was used on 70% of the area treated with herbicides in the Vancouver Forest Region in 1988 and 2,4-D was used on almost all the rest (Humphreys 1989). Registration of new herbicides is a slow and expensive process, and therefore the range of chemicals available to forest managers will probably expand slowly.

Weeding and cleaning by hand can be conducted with a number of tools, including non-motorized cutting blades and powered brush saws. Manual treatments require a great deal of manpower for treating large areas and are often effective for only one or two growing seasons, so they are not likely to be used extensively as long as safe, cheaper, and more effective herbicides are available.

Cleaning and weeding usually reduce the quality of deer habitat because they remove much of the forage available to animals. Some of the factors that determine the seriousness of the negative impact are the species of plants killed, the proportion of the understory eliminated, the duration of the reduction in forage abundance, and the amount of forage available in other areas nearby. Broadcast application of herbicides over key feeding sites such as small spring ranges or hygric-site stands of alders may affect deer and elk severely; in contrast, spot herbicide treatments from the ground or manual cutting of alder and other hardwood trees may have no important consequences. According to Newton and Knight (1981), 2,4-D can even be used to enhance forage availability if it is applied during spring to kill the tops of tall shrubs and hardwood trees, thus encouraging sprouting near ground level. Also, herbicides may benefit deer or elk forage by decreasing bracken fern or unpalatable shrubs and allowing herbaceous species to grow. Generally, though, the greater the control of understory that is achieved, the poorer the forage production will be.

While the major impact of weeding is on forage abundance, cleaning (removal of woody competitors with crop trees) further decreases the habitat value of stands by opening them up to view and to wind penetration. In extremely dense stands, on the other hand, cleaning can be beneficial to deer and elk if it makes the stands more accessible and does not generate excessive slash.

Table 8. Characteristics of herbicides commonly used on forest lands in coastal British Columbia. Sources: Newton and Knight (1981) and Council of Forest Industries of B.C. and B.C. Ministry of Forests (1985)

Common and trade names	Active ingredient	Method of application	Effective on	Ineffective on
Glyphosate Roundup®, Vision®	N-phosphonomethyl-glycine	Foliar spray, tree injection, stump treatment	Herbs, deciduous shrubs and trees, some ferns including bracken, conifers (through tree injection)	Evergreen trees and shrubs, both coniferous and broad-leaved
2,4-D	2,4-dichlorophenoxyacetic acid	Tree injection, stump treatment, foliar spray (uncommon)	Forbs, most shrubs, hardwood trees, and some conifers during late winter through summer	Grasses, bracken fern, salal

Thinning (including juvenile spacing)

Immature forests can be thinned for several purposes: to salvage trees that have died or will die shortly, to remove weak or poor-quality individuals from the stand, and to optimize merchantable volume or product quality by concentrating growth on an appropriate number of the most vigorous and well-distributed stems (Daniel *et al.* 1979). Thinning can start as early as age 7 (i.e., when the dominance or relative vigour of some trees is first apparent), but more commonly it begins at a stand age of 10-20 years. As a result of small tree sizes at that age, cut stems are normally not used, and the activity is called **non-commercial thinning** (usually "juvenile spacing" in British Columbia and "pre-commercial thinning" in the U.S. Pacific Northwest). Non-commercial thinning may also occur in stands older than 20 years, particularly in stands that should have been treated earlier but were not ("backlog spacing") or on poor sites where growth is slow. Many thousands of hectares of 25- to 40-year-old stands were thinned from 1977 to 1983 as the intensive forest management program began on coastal Crown land.

Most non-commercial thinning is conducted with chainsaws, but a small proportion employs chemical treatment of trees that are left standing to die. Post-thinning densities of live trees are variable, ranging from 400 to 1200 stems per hectare in Douglas-fir and from 400 to 1600 per hectare in western hemlock and amabilis fir stands (Nyberg 1985). Some of the variation is due to differences in product objectives and yield models used by companies and the Forest Service, some to site quality variations, and some to differences in the future treatments planned for stands, especially whether or not a commercial thinning is anticipated. Stands scheduled to provide an eventual crop of sawlogs without commercial thinning at an intermediate age are usually thinned the most heavily, commonly to 400-600 per hectare. Those on medium and poorer sites, from which forest managers want the maximum volume of merchantable pulpwood or on sites where commercial thinning is anticipated, are usually thinned to 750-1700 stems per hectare. Non-commercial thinning is most common in stands dominated by Douglas-fir, but in recent years extensive programs have begun in western hemlock and amabilis fir. Since 1983-84, an average of 7800 ha of Crown land have been non-commercially thinned annually in the Vancouver Forest Region.

Commercial thinning is applied to older stands, usually 40 years old or more, in which the felled trees are large enough to be used profitably for lumber or pulp. Poor markets for small logs in recent years have greatly limited opportunities: only 210 ha of Crown land in total were commercially thinned between 1983-84 and 1987-88. Stands dominated by Douglas-fir are the only ones likely to be treated in the next few years. Tree density after commercial thinning is usually 250-350 stems per hectare, although more trees may be left if subsequent thinning is planned. Yarding systems in commercial thinning operations can use horses, small portable winches, tractor-mounted mini-yarders, or rubber-tired skidders.

The major effect of thinning on deer and elk habitat is to encourage growth of the understory by reducing tree competition, thus increasing available light, moisture, and nutrients. This is the single greatest benefit of intensive silviculture for the animals. The period of greatest forage abundance can be extended for many years in young stands thinned as the canopy is closing (Figure 81). In older stands, with sparser understories, some increase in abundance is also possible (Nyberg *et al.* 1990a).

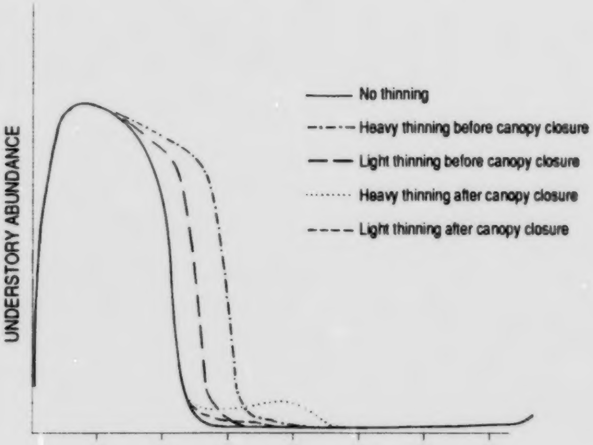

Figure 81. Generalized trends in understory abundance as affected by thinning weight and timing.

Several factors influence the degree and duration of understory responses. First, the most dramatic forage gains occur when non-commercial thinning is carried out early, that is, before or at the time the forest canopy first starts to close. At that time, most of the lush vegetation that flourished in the clearcut opening will still be present, and re-opening of the canopy with thinning will ensure continued abundance of the understory for several years. On the other hand, thinning that takes place after several years of heavy shading caused by dense tree canopies will produce a much smaller benefit because most understory plants will have died out.

Site conditions also influence understory reactions to thinning, because they affect species composition (understory type), tree growth rates, and crown dimensions. On the driest forested sites, tree growth is so slow that even after 25-30 years, the understory may still be abundant, especially when it comprises species like salal that compete efficiently for moisture (Figure 82). On such sites even thinning to 900 trees per hectare may produce a significant response lasting 10-15 years (Nyberg *et al.* 1990a). On moister sites such as the Huckleberry - Moss understory type (Appendix 1) where shrubs are less efficient at competing for moisture, trees close canopy much earlier, resulting in a more rapid decline in understory vegetation. Thinning must be heavier and occur earlier on such sites if understory abundance is to be sustained for long.

Generally, thinning of stands to 450-600 stems per hectare when the canopy first begins to close (7-18 years of age) can be expected to maintain most or all of the forage species present in the stand at the time of planting, and to extend the period of understory abundance for 10-15 years. Such stands can provide good spring and summer forage in all snowpack zones, but during winter snow will often bury the plants, especially in the deep and very deep snowpack zones. Thinning to 800 stems per hectare or more will produce a smaller response of shorter duration. Stands with 1000-1200 stems per hectare after thinning can be expected to produce extra forage for only 5 years or so after treatment, except on some dry salal-dominated sites.

Responses of understory vegetation in backlog spaced or commercially thinned stands are much less dramatic, in part because of the disappearance of many forage species from such stands as a result of intense tree competition before thinning. Only those species that are found in the stand before thinning are likely to occur in the more open conditions afterwards. Many of the nutritious forbs and grasses that make spring range so valuable are pioneer species that quickly disappear from closed-canopy stands. Only with heavy commercial thinning (to 200-250 stems per hectare) on moist sites that already have good spring forage species in the understory (usually the Deer fern, Oak fern, Salmonberry, and Sword fern understory types) will good spring range be produced. Shrub species are more persistent in shady stands, but may still need heavy thinning to encourage a significant response. Light commercial thinnings, such as would be used in a multiple-entry thinning regime, will produce no important increases in forage. Appendix 1 presents more information on thinning responses in specific understory types.

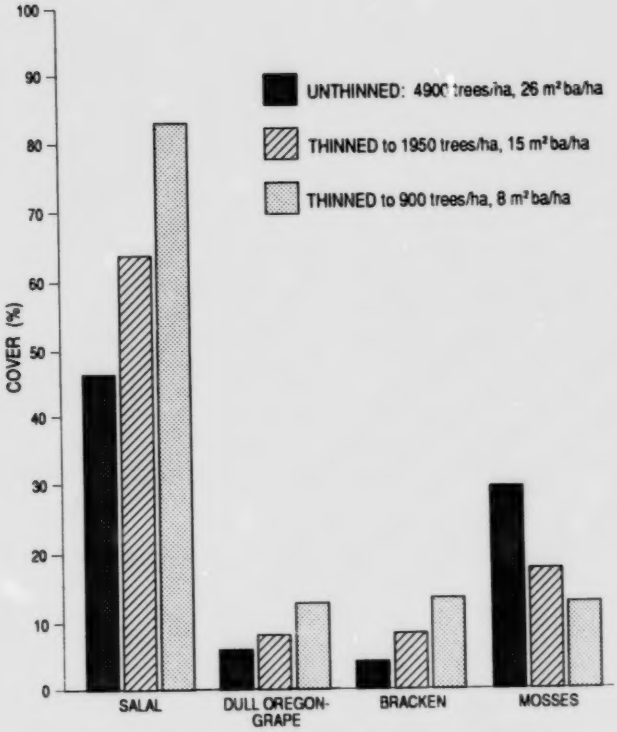

Figure 82. Abundance of selected species and species groups as affected by two levels of commercial thinning in a Douglas-fir stand (Salal - Huckleberry understory type, site class = poor). The stand was thinned 25 years after establishment and sampled 11 years later (Nyberg et al. *1990a) (ba = basal area).*

Downed trees in non-commercially thinned stands can pose a severe mobility problem for deer and elk (Figure 83). These problems are most severe when cut trees are large or especially dense, for example, in backlog stands or very dense western hemlock stands. Debris over 30 cm high, especially if there are more than 25 obstacles per 100 m, can significantly reduce elk and deer use. However, in stands thinned before age 15, such debris is normally small in size and therefore quick to rot, making the debris problem short-lived (5-7 years at most). Chemical thinning may offer a solution to the debris problem in older and denser stands because standing dead trees will decay slowly.

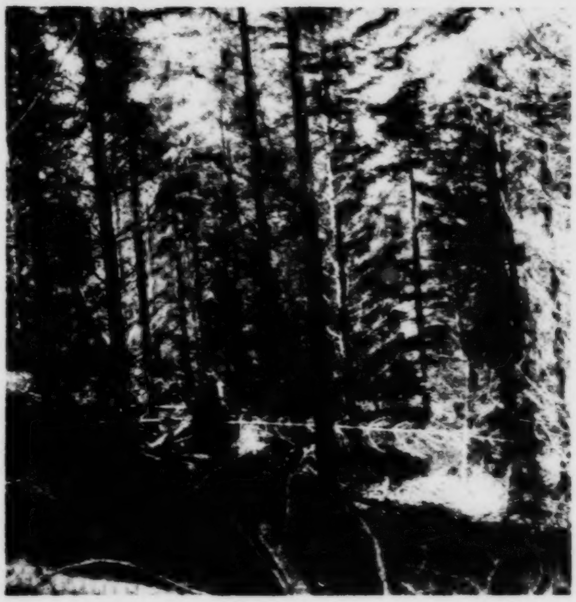

Figure 83. Downed trees in backlog non-commercially thinned stands can severely restrict elk and deer use of the stand.

Thinning reduces both security and thermal cover values by making animals more visible, opening the overstory, and allowing wind to penetrate more easily. In rare cases, subsequent understory growth may restore some of the windbreaking and security values. Snow interception cover is also poorer immediately after thinning because of the openness of the canopy. Yet, it may eventually be better (once the canopy recloses) than it would have been if thinning had not taken place, because wider crowns and stronger branches will be produced by the fewer competing trees.

Fertilizing

Fertilization of coastal stands has been an intermittent activity in recent years, fluctuating with the budgets of management agencies. From 1980-81 through 1982-83, fertilizer was applied to 27010 hectares of Crown land, but the program then ceased entirely due to budget constraints. After 1985, new funding for intensive forest management provided for the fertilization of an average of 5900 ha each year.

Although stands can be fertilized at any time from planting to just before harvesting, most coastal stands are fertilized immediately after being thinned. The only commonly used nutrient is nitrogen, which is applied as urea at a rate of 200-225 kg N/ha. Recent findings, however, indicate that other fertilizer formulations, including nitrogen-phosphorus combinations and nitrogen supplemented with micronutrients, may be more effective than urea alone for certain sites and species (F.C. Nuszdorfer, B.C. Ministry of Forests, pers. comm.). Also, the use of balanced, slow-release fertilizers at the time of planting appears promising as a method of boosting initial seedling growth. Thus, a trend towards more varied fertilization practices can be expected in the next few years.

Effects of fertilization on deer and elk habitat are minor. Thermal and snow interception cover may be improved after several years as a result of increased crown growth, but concomitant increased shading will reduce understory abundance in lightly thinned stands (Figure 84). In heavily thinned stands (<700 stems per hectare) or on poorer sites where tree density is less than 1000 stems per hectare, fertilizers will encourage both improved quality and quantity of forage. The higher nitrogen content of forage will be short-lived, however: no more than 5 years, and often less. Two years after fertilization of *Vaccinium alaskaense* (Alaskan blueberry) with ammonium nitrate at 225 kg N/ha, the protein content of twigs during winter was no higher than in unfertilized plants (D. Janz, B.C. Ministry of Environment, unpublished data). Although increases in quantity of forage will be more persistent, they are usually of small magnitude. Fertilization combined with heavy thinning may be an ideal regime for producing spring forage, though, particularly if repeated fertilizer applications encourage herbaceous vegetation rather than ericaceous shrubs (Rochelle 1979).

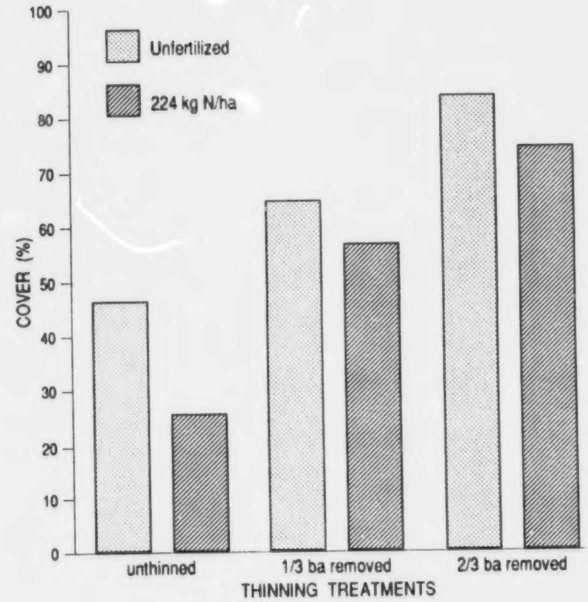

Figure 84. *Salal abundance in a Douglas-fir stand (Salal - Huckleberry understory type, site class = poor) as affected by thinning and fertilizing. The stand was thinned 25 years after establishment and sampled 11 years later. The unthinned plots averaged 44 square metres basal area (ba) per hectare and 3800 trees per hectare.*

Pruning

Pruning is used to increase the proportion of knot-free lumber from young trees (Daniel *et al.* 1979). Long regarded by most silviculturists as being of questionable economic benefit as long as old growth remains available, pruning has seldom been done on the coast. A few small areas have been treated in recent years, some to enhance lumber quality and some for purposes of fire and disease protection, aesthetic enhancement, research, and demonstration. Recent evidence indicates that pruning of lower branches of Douglas-fir may benefit tree growth as well as improve wood density and eliminate knots (Di Lucca 1987). If these benefits are confirmed by further research, pruning may become an important component of specialized forest management regimes.

Trees are normally pruned to a height of one log length (5.5-6 m), but occasionally ladders are used to reach higher. Trees respond best to pruning if they retain live branches for at least half their height and if branches are cut when small. Therefore, pruning is best done in several "lifts" which remove live branches from successive 2-m lengths of the bole at intervals of several years (Figure 85).

Security cover can be seriously reduced by pruning, especially when the lowest live branches are cut. Pruning of all trees to 3 m or higher can eliminate the security cover value of a young stand. Access to the stand may be marginally increased as a result of the removal of branches close to the ground, but this is not important in low-density stands which are the only ones likely to be pruned. Forage values will be increased somewhat because more light will be made available to the understory at the base of the trees. Pruning in such cases may produce effects similar to non-commercial thinning, and could allow forest managers to carry more trees per hectare while producing as much forage as a more heavily thinned, unpruned stand.

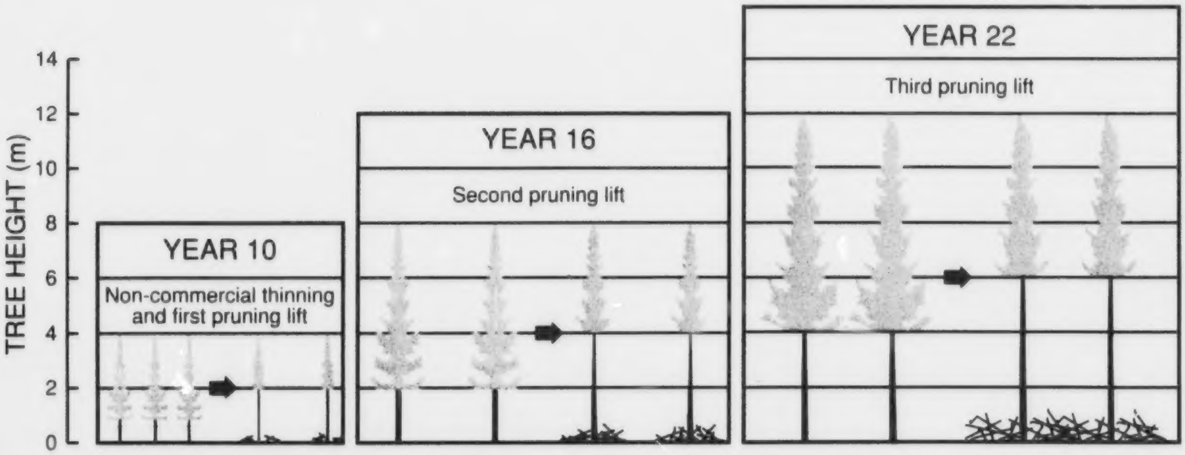

Figure 85. An example of a three-lift pruning sequence.

Summary of effects on deer and elk access and habitat

ROADS

Effect on access:
A minor benefit to deer and elk until tall, dense vegetation grows in after roads are abandoned. **A moderate to major detriment if roads are dense and heavily travelled, or if busy roads are located immediately adjacent to important special habitats.**

Effect on cover:
A minor detriment as a result of removal of trees during construction.

Effect on forage:
Beneficial in both the short and long run because of the early successional vegetation produced within the cleared right-of-way.

LOGGING

Effect on access:
Detrimental when slash is deep (>30 cm) and abundant (>25 obstacles/100 m).

Effect on cover:
A major detriment until a new stand reaches 2 m in height. Loss of snow interception cover may be critical for deer in some areas. Loss of thermal and security cover may be ameliorated if patches of small residual trees remain or if patch size is small.

Effect on forage:
A minor detriment in the first year after logging as a result of the destruction of understory plants. **A major benefit for deer in the long run because of the increased herb production initially and increased shrub production later (if cover is available nearby).** A minor benefit for elk. Benefits may persist for 20 years.

SITE PREPARATION

Effect on access:
Beneficial when burning or piling significantly reduces slash.

Effect on cover:
Burning is slightly detrimental if it removes advance growth or slash piles that provide cover in large open areas. Piling or windrowing improves security cover, usually to a minor degree.

Effect on forage:
Detrimental until the understory recovers. **Then a major benefit for summer and winter forage production from year 2 following treatment until the new stand closes canopy, unless fire is so hot that it kills below-ground portions of important forage shrubs.**

REGENERATION

Effect on access:
Detrimental where extremely dense stands (10000 stems per hectare and more) more than 2 m tall occur. A minor detriment due to the limited extent of such stands.

Effect on cover:
Beneficial in the long run (beginning 5-20 years after logging) because conifers provide the best thermal, security, and snow interception cover.

Effect on forage:
A minor benefit to deer and elk for a few years after establishment because young conifers provide an extra food source. **A major detriment in the longer run (beginning 7-20 years after logging) because of the reduction of understory forage.**

SPECIES CONVERSION (See effects of component activities)

WEEDING AND CLEANING

Effect on access:
A minor benefit in very dense stands of conifers (>10000 per hectare) or shrubs such as salmonberry, unless slash is excessive.

Effects on cover:
Detrimental because animals are more visible and wind penetrates better. A minor detriment if conifers respond quickly.

Effect on forage:
A major detriment in key feeding areas, especially spring ranges of deer and wet sites used by elk. Less significant if alternative feeding areas are available, if all understory plants are not killed, or if plants resprout quickly. Beneficial if used to rejuvenate excessively tall forage plants through basal sprouting.

THINNING

Effect on access:
A minor detriment when non-commercial thinning is conducted about the time the crowns first close. **A potentially major detriment in very dense hemlock stands (>5000 stems per hectare before thinning) and especially in backlog-spaced stands.**

Effect on cover:
A minor detriment to security, thermal and snow interception cover immediately after thinning.

Effect on forage:
A major benefit if stands are thinned to <600 stems per hectare when the understory community is abundant and vigorous. A minor benefit if thinning occurs after several years of crown closure and if thinning is light (i.e., if >700 stems per hectare remain after non-commercial thinning or >400 stems per hectare after commercial thinning).

FERTILIZING

Effect on access:
None.

Effect on cover:
A minor benefit to thermal cover after several years due to larger crowns on trees. More significant benefits to snow interception after the canopy recloses, as a result of wider crowns and more vigorous growth.

Effect on forage:
Minor effects in the form of a short-term increase in forage quality because of increased nitrogen content, a small increase in forage biomass if combined with thinning to 700 stems per hectare or less, or a small decrease in forage biomass if accompanied by lighter thinning or no thinning.

PRUNING

Effect on access:
A minor benefit.

Effect on cover:
A major detriment to security cover in young stands if all trees are pruned up 3 m or more.

Effect on forage:
A minor to moderate benefit in dense young stands where live lower branches of adjacent trees shade the understory.

DEER AND ELK IMPACTS ON TIMBER MANAGEMENT

This section examines the "other side" of the forestry-habitat issue dealt with in the rest of the handbook; that is, it describes how elk and deer affect trees and forestry programs, rather than how trees and forestry programs can affect animals and their habitat.

Three major categories of animal impacts are discussed:[11]

- damage to trees, including browsing, uprooting, bark stripping (elk only), and antler-rubbing;
- reductions in the land base for timber production, allowable annual cut (AAC), and operating flexibility of timber companies as a result of habitat management constraints restricting forestry activities on some sites; and
- reductions in timber volumes, AAC, or product values in young growth as a result of modifications to forestry regimes for the purpose of intensive habitat management.

These effects translate into direct economic costs or opportunity costs that are eventually borne by government or the forest industry. As it is in the best interest of both timber and habitat managers to minimize unnecessary costs, this section provides some guidance on techniques for reducing deer and elk impacts.

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[11] Hunters and other recreationists seeking elk and deer affect the timber manager's resources and programs (for example, by causing damage to roads and property), and forest development and management affect recreation (for example, by improving road access), but those issues are not explored here as they are peripheral to the handbook's purpose.

Damage to Trees

Both deer and elk cause damage to trees. Deer damage is a much more important concern to silviculturists than elk damage because deer are more numerous and widely distributed (Howard 1982). In a few localities where elk concentrate seasonally, however, damage has been very severe for several years.

Most deer and elk damage occurs when the animals feed on trees. Both species eat substantial amounts of coniferous foliage during certain seasons. Western yew appears to be the most highly preferred coniferous tree for both species (Figure 86), but it is not a commercial timber tree. Of the commercial species, western redcedar is usually most heavily damaged by deer and elk. Douglas-fir is also heavily browsed on many sites by deer; hemlock and true firs are damaged by elk in some places; and even Sitka spruce may be severely damaged by very dense deer populations Figure 87).

Other types of damage to trees are much less common than browsing damage. Small seedlings are sometimes uprooted in the first days or weeks after planting, by deer or elk pulling at their tops to break off twigs when browsing. Elk are also known to do the same to natural hemlock seedlings. Elk sometimes strip the bark from pine, willow, alder, and Douglas-fir during winter so they can eat the cambial layer. Both elk and deer damage small numbers of trees during late summer in polishing the velvet off their antlers, and damage more trees and shrubs by "horning" them as part of their social displays (Geist 1981, 1982) during the rut. Horning damage is usually worst on saplings 2-4 m tall, but it can also affect pole-sized trees, particularly isolated trees near areas of elk concentration such as wallows.

Whereas the latter types of damage are usually of local, short-term concern to foresters, browsing damage is a major problem in many areas with moderate or high deer populations. The major impact on timber programs is the loss of growth

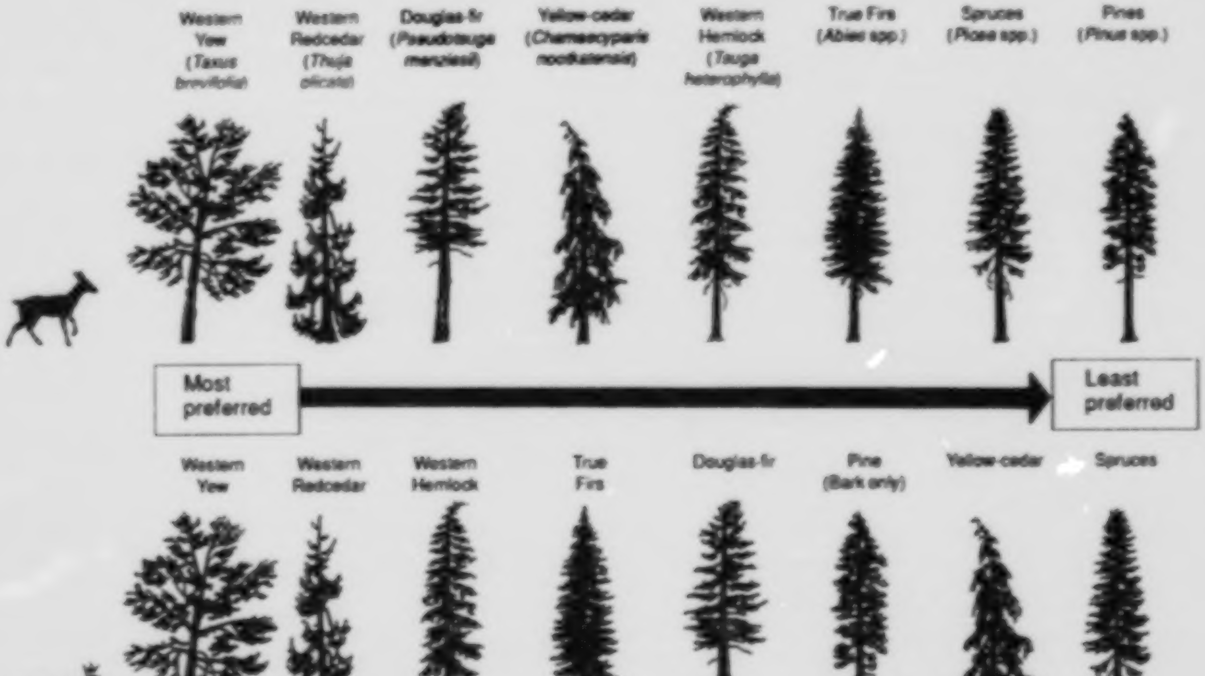
Western Yew (*Taxus brevifolia*)
Western Redcedar (*Thuja plicata*)
Douglas-fir (*Pseudotsuga menziesii*)
Yellow-cedar (*Chamaecyparis nootkatensis*)
Western Hemlock (*Tsuga heterophylla*)
True Firs (*Abies spp.*)
Spruces (*Picea spp.*)
Pines (*Pinus spp.*)
Most preferred
Least preferred
Western Yew
Western Redcedar
Western Hemlock
True Firs
Douglas-fir
Pine (Bark only)
Yellow-cedar
Spruces

Figure 86. Relative preferences of deer and elk on Vancouver Island for coniferous forage. This sequence was derived from diet analyses (Gates 1968; Rochelle 1980) and field observations of IWIFR and other staff. Local variations in preferences can be expected.

Figure 87. Even Sitka spruce may be heavily browsed when deer populations are dense.

caused by loss of foliage, but heavy and persistent browsing can also kill trees, requiring expensive replanting.

Unfortunately, prediction of where and when browsing damage will be a problem is no easy matter. Among the many factors contributing to the degree of damage seen on various sites are the density of animals, the tree species present, seedling size, availability of alternative forage, amount of slash, winter weather, the habitat pattern nearby, and the site's topographic position. The greatest problems tend to occur in areas of high deer populations, when small seedlings (e.g., 1-0 bareroot, 2-0 plug) of a highly preferred species are planted into areas that provide little else as alternative forage (such as clearcuts burned the preceding autumn). Even where deer and elk populations are smaller, sites of seasonal concentrations of animals, such as south slope winter and spring ranges, can experience heavy damage (Figure 88).

All browsing is not a serious problem for foresters, though. Once roots are well established, trees can usually recover from browsing as long as laterals with healthy buds remain. Even sustained heavy browsing will not kill most trees. Planted Douglas-firs on Texada Island were heavily browsed for 10 years, but eventually developed a wide-based "pincushion" shape that allowed the leader to grow above the reach of deer (F.T. Pendl, B.C. Ministry of Forests, pers. comm.). Such heavy damage may increase the tree's susceptibility to insects and diseases, however, and loss of 10 years' growth could extend the rotation period by as much as 20%.

Figure 88. Openings adjacent to critical winter ranges often experience heavy browsing damage because many animals congregate in the area during winter and early spring.

Many techniques have been applied to prevent or reduce browsing damage, especially on Vancouver Island. Space does not allow complete discussion of all the methods that may be useful, but the following section gives an overview of some of the most important methods and factors.

Control of browsing damage

Browsing control methods can be grouped into four general categories:

1. protection of trees;
2. reduction of the animal population;
3. provision of alternative foods; and
4. modifications to planting practices.

PHYSICAL AND CHEMICAL PROTECTION

The most common approach to browsing damage control has been to protect trees, using either physical or chemical means, from the animals. Unquestionably, the most effective and reliable technique is construction of a deer- or elk-proof fence. A vertical mesh fence at least 2.5 m high is needed to keep deer from jumping over, but much shorter electrified and slanted fences (Messner *et al.* 1973; Brenneman 1982) have been used successfully outside British Columbia. Fencing has long been considered too expensive for widespread use in coastal British Columbia, and has been confined largely to special areas such as the Victoria watershed and research plots elsewhere. With the increasing costs of other techniques and the demonstrated long-term effectiveness of fencing, however, it may prove to be more practical in future.

A much more common approach has been to protect individual trees with tubes, sleeves, or cages of plastic or wire. Many different materials and sizes are available, but coastal foresters have usually used plastic mesh tubes of approximately 7.5 cm diameter (Figure 89). These protectors are most successful if they are installed carefully (i.e., securely staked) and if they degrade at a predictable rate as promised by at least one manufacturer (International Reforestation Suppliers 1985). They are expensive, however, with materials and labour for each tube costing as much as the seedlings, and are not always fully effective in preventing seedling damage. Furthermore, as the seedling grows, the protector may need to be moved up to protect the leader, adding additional labour costs.

Other devices are also available for individual tree protection, including bud caps, leader tubes, and wire cages. In some situations, these may be more cost effective than large mesh tubes (Schaap and DeYoe 1986).

Natural features of the site may also be used to protect seedlings. For example, planters can be instructed to plant shade-tolerant tree species between logs, piles of slash, and stumps. Slash can also be deliberately piled around planting spots during spot site preparation. Small backhoe-loaders are frequently used for this type of site preparation on northern Vancouver Island and can be used to construct a partial "slash fence" around some planting spots. As the deterrent effect of the slash on deer and elk movement will not be the same at all spots and hungrier animals will work harder to reach the trees, the effectiveness of this method can be expected to vary greatly.

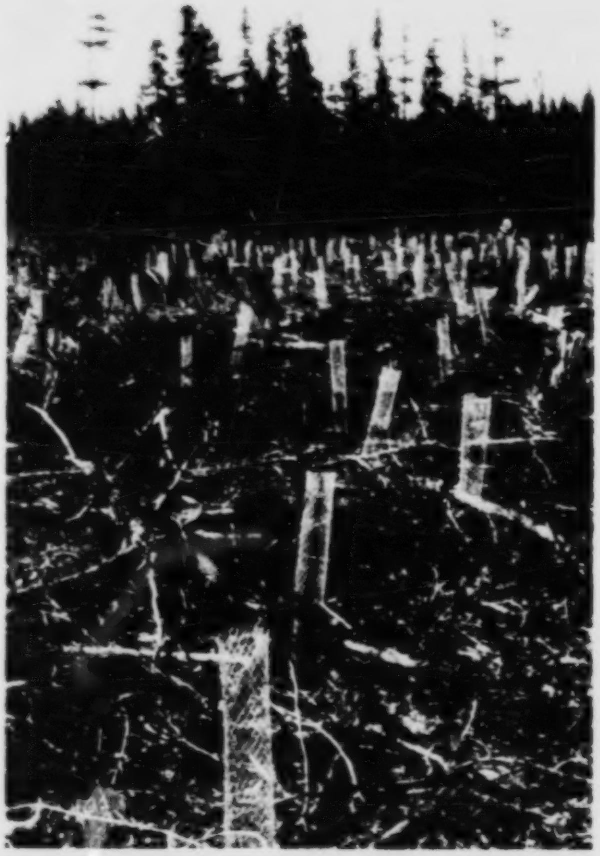

Figure 89. Plastic seedling protectors are widely used to shield planted seedlings from deer and elk browsing.

Chemical protection of seedlings using various types of repellents has long been a popular notion because it promises low costs for materials and easy, quick, portable application. Materials that have been tested in North America for repelling deer include tar, capsaicin, rotted organic matter, and various synthetic compounds. As yet, though, few have been found satisfactory for use in coastal British Columbia, either because they are not sufficiently repellent to reduce browsing damage significantly or because they do not persist long enough on foliage or bark in the wet climate of the coast.

The best of the commercially available repellents seem to be those based on putrefied organic matter, which gives off a strong odour. Both a liquid spray and a powder that can be dusted on wet trees are available. Repellent effect persists for 3 months to 1 year according to most reports. The biggest disadvantages of this type, like other repellents, are that it protects only the foliage and twigs to which it is applied and that it eventually degrades or washes off.

New products based on super-bitter compounds and predator scents are currently being tested (D. Seip, B.C. Ministry of Forests, pers. comm.). Any repellent, no matter how effective, will only be practical as a tool for reducing browsing damage if it is applied in an area where ease of access, distance, and availability of inexpensive labour make it feasible to return once per year or more to reapply the material.

POPULATION REDUCTION

A technique often suggested by foresters for reducing deer and elk damage is to reduce the animal population through liberalized hunting seasons or special animal-control hunts. For a number of reasons, this approach has never been considered feasible for deer and elk.

First, it is extremely difficult for hunters to kill a large proportion of coastal deer populations, because the animals are small, secretive, and very effective at hiding in the dense coastal vegetation (Smith 1971). Even with a great deal of effort to institute a special damage-control hunt in a small well-roaded area of Washington State, the rate of terminal browsing was reduced only from 54 to 35%. Crouch (1980) concluded that this small reduction of damage may not have been justified by the effort required to plan, publicize, and administer the special hunt. Second, wildlife managers are concerned about the difficulty of monitoring the harvest of deer from special damage-control hunts. The extensive networks of coastal forest roads would allow poachers to claim that illegally killed deer came from the area of the special hunt. Finally, although elk damage could be more effectively controlled with special hunts because of their visibility and herding behaviour, their susceptibility to over-killing leaves wildlife managers even less enthusiastic about damage-control hunts for elk than for deer. Elk damage also tends to be more localized than deer damage, so population reduction would be an over-reaction in most cases.

Predators can benefit timber management indirectly by reducing deer and elk populations, so it is possible that transplants of predators might have a long-term effect in areas like the Queen Charlotte Islands which have never had wolves or cougars.[12] Transplanting of predators beyond their historical ranges, however, carries large risks of unwanted or unforeseen reductions to non-target animals and would not be easily accepted by the public.

PROVISION OF ALTERNATIVE FOODS

As mentioned earlier, some of the worst browsing damage occurs on recently burned sites that offer no alternative foods. This correlation, plus the well-known preference of deer and elk for a varied diet, has suggested to many biologists that browsing damage to conifers might be reduced if substantial amounts of preferred forage were provided in planted clearcuts. Native forage might be encouraged with the prescription of site preparation treatments that conserve or promote increased growth of species already present on the site (e.g., cool spring burns rather than hot fall burns), or the establishment of a herbicide-free buffer near patches of cover (where damage is likely to be worst) when weeding and cleaning.

If native species alone are not likely to provide sufficient food, non-native species might also be planted. This approach has been widely used in coastal Oregon, where legume-grass mixtures are seeded for elk (State of Oregon 1980), and in western Washington where native deer forages have been seeded (Campbell and Evans 1978; Campbell and Johnson 1981). The key factor is that the alternative forage species must be palatable and preferred during the season(s) when elk or deer would tend to browse conifers.

Seeding of alternative forage has not been successful for reducing either deer or elk damage in British Columbia, but the approach is being tested in limited trials (e.g., Brunt *et al.* 1989). Its effectiveness and cost appear worthy of further evaluation.

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[12] Pojar, J., T. Lewis, H. Roemer, and D.J. Wilford. 1980. Relationships between introduced black-tailed deer and the plant life of the Queen Charlotte Islands, British Columbia. B.C. Min. For., Smithers, B.C. Unpubl. report. 63 p.

MODIFICATIONS TO PLANTING PRACTICES

By planting less palatable species instead of western redcedar or Douglas-fir, the seriousness of browsing damage can be greatly reduced. Where this is not possible or desirable, use of larger stock provides a greater mass of photosynthetic material, which allows the tree to recover from browsing more quickly. Also, the greater height of large stock means a smaller height gain is necessary before the tree reaches the point (at approximately 1.5-2 m) where its leader will be too tall for deer or elk to reach. And finally, planting later in the spring rather than immediately after snow melt will allow native plants to flush first, providing a mass of high-quality forage to draw animals away from the newly planted seedlings.

Habitat Management Constraints

The largest impact (in monetary terms) of deer and elk on forestry programs, and the one that has generated the most controversy, is the opportunity cost incurred by industry and government when logging and forestry plans must be modified to protect or enhance habitats.

Most commonly, these costs arise when harvesting of mature and old-growth timber is postponed or foregone to preserve winter or spring range for deer and elk. The costs result from:

1. the need to build additional roads to timber that is less accessible than the protected winter and spring ranges;
2. the restriction of operating flexibility and seasonal timing of operations when easily accessible timber at low elevations is protected; and
3. reductions in the timber land base, level of harvest, and employment.

The magnitude of wildlife habitat constraints is illustrated by the total area withdrawn from the productive forest land base as Environmentally Sensitive Areas for wildlife, in the calculation of allowable cuts for TSA's (Table 9). Most of these areas were identified specifically for deer and elk habitat, and reductions of 90 or 50% were applied to the volume of timber they contribute to the allowable cut calculations. Further areas are currently deferred from harvesting for undetermined lengths of time, both within and outside TFL's, but the level of harvesting has not been reduced to account for these deferrals in all TFL's because it has been assumed that the areas would be harvested sooner or later. In the case of TFL's 37 and 39 on north-central Vancouver Island, approximately 10 000 ha are deferred for winter range protection (B.C. Ministry of Environment and Ministry of Forests 1983), most of which were designated for deer. Management of young forests as winter and spring habitat for deer and elk (see Chapter 5) may reduce the need for reservation of mature and old-growth timber, but it carries its own costs, as discussed in the next section.

Table 9. Area on the south coast designated as Environmentally Sensitive Areas (ESA's) for wildlife during inventory update for Timber Supply Area yield analysis. Tree Farm License areas are not included.

TSA	Productive Crown forest land (ha)	Area of wildlife ESA's (ha)
Arrowsmith	115 000	800
Fraser	519 000	4100
Kingcome	521 000	4000
Soo	234 000	3200
Strathcona	350 000	8200
Sunshine Coast	519 000	1300

Source: TSA reports, Vancouver Forest Region, Burnaby, B.C.

Costs of Intensive Habitat Management

Recent research indicates that intensive silvicultural practices, perhaps in combination with special habitat improvement techniques such as shrub planting, grass seeding, or lichen dispersal, might be used to create suitable winter and spring habitats for deer in young forests that can later be harvested (Nyberg *et al.* 1986; R.T. McLaughlin, MacMillan Bloedel Ltd., unpublished data). These habitat management regimes may result in both direct and indirect costs that would not be incurred in regimes designed strictly for timber production.

Direct costs would result from additional practices not normally incorporated in stand management, such as shrub planting, lichen dispersal, extra fertilization, or extra thinning treatments that could be used to enhance forage production (Figure 90). Indirect costs might arise from lowered timber quality or volume that could result from the stand conditions required to meet deer and elk habitat objectives. The most common problems would likely be reduced harvest volume, increased proportions of juvenile wood, increased ring width, and excessive branching as a result of growing stands at the lower densities required to maintain forage production. On the other hand, potential compensating benefits for timber management from low-density regimes include reduced costs for treating stands with fewer trees, increased piece sizes at the time of harvest, and shorter rotations to achieve objectives for minimum tree size. Furthermore, successful application of these approaches may allow earlier harvest of some deferred old growth or the enhancement of wildlife populations in areas that currently are short of winter or spring range.

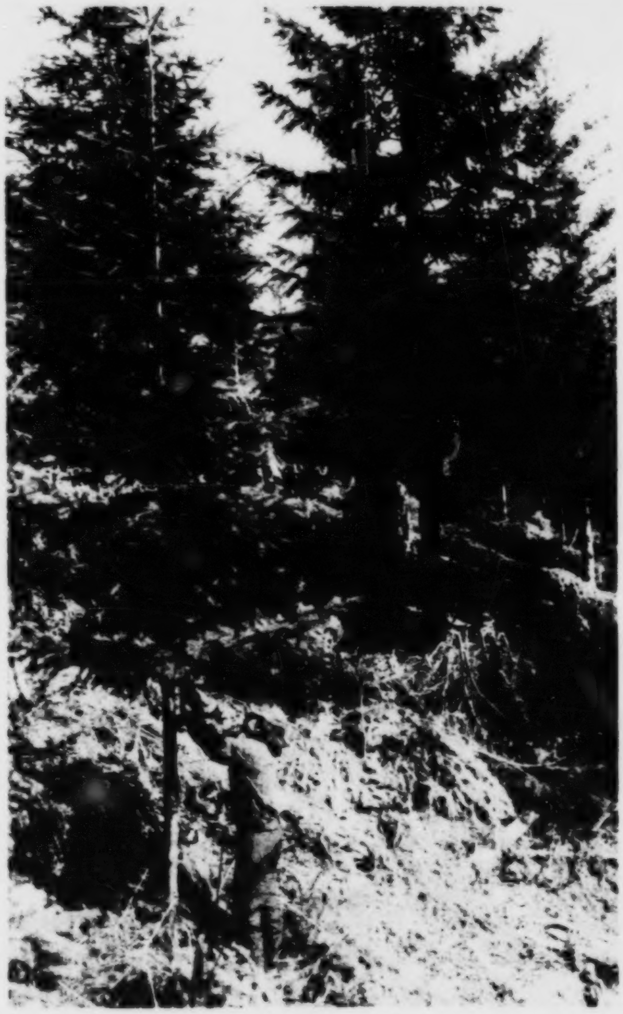

Figure 90. Heavy thinning and pruning are two treatments that form part of regimes being tested for creating deer winter ranges in young stands.

IMPORTANCE OF TIME AND SPACE

Throughout the latter sections of this chapter, the emphasis has been on the effects of individual forest management activities (e.g., logging) or of animal activities (e.g., browsing). This approach allows for a clearer explanation of the basics of the issues, but it is also simplistic because it ignores the influences of time and space. The chapter closes here with a few comments on these factors.

No manager should attempt to plan a program of integrated wildlife and timber management without looking beyond individual sites to consider surrounding vegetation, or without thinking about cumulative effects of succession and future forestry activities. For example, the detrimental effect of thinning on security cover will usually be of little importance if the thinned block is small and adjacent stands provide cover in abundance. On the other hand, heavy thinning of a stand located between a road and a bog that is used heavily by elk may seriously reduce elk use of the area. As another example, a few years of extensive clearcutting may leave a pattern of forage and cover that makes ideal deer habitat. Either further cutting that eliminates winter range, or cessation of cutting for a 20-year period of regeneration during which forage disappears, may reduce habitat capability to near zero.

The importance of time and space will become more apparent when managers attempt to plan for long-term production of habitat in conjunction with timber management. No matter how good or bad the effect of a given practice is on one site, the pattern of stands and the sequence of activities through time will prove to be far more significant in determining the capability of the area to produce deer and elk. Chapter 5 discusses the application of techniques to manage habitat in the context of stand development through the rotation.

Chapter 5

Techniques for Managing Habitat

by

D.Q. Becker, F.L. Bunnell, D.W. Janz, J.B. Nyberg, and E.L. Richardson

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INTRODUCTION

This chapter describes a number of principles and forestry techniques helpful in managing the integrated production of timber, elk, and deer. The information from earlier chapters and Appendix 1 is used to describe several specific relationships and recommended practices. This chapter should be the section of the handbook most useful for development planning and managing site-specific areas.

This is not a chapter of simple habitat prescriptions. Instead, guidance is provided to indicate the most promising habitat management strategy for most situations. Where our knowledge of habitat relationships allows it, information is presented so that managers can evaluate the outcomes of alternative habitat or timber management plans. This approach allows local decisions to reflect local conditions and priorities, and recognizes that better information may become available. In certain cases, however, a single set of suggestions for habitat objectives and techniques is provided because that is the best information currently available. For example, only the approach currently judged to be most suitable for managing young stands as winter ranges for deer in the moderate snowpack zone is described.

How the Chapter Is Organized

Information in Chapter 5 is organized by **snowpack zone** (shallow, moderate, deep, and very deep as shown in Figure 91) and type of **seasonal range** (winter, spring, and summer). This will allow managers to quickly find the material that describes their management area.

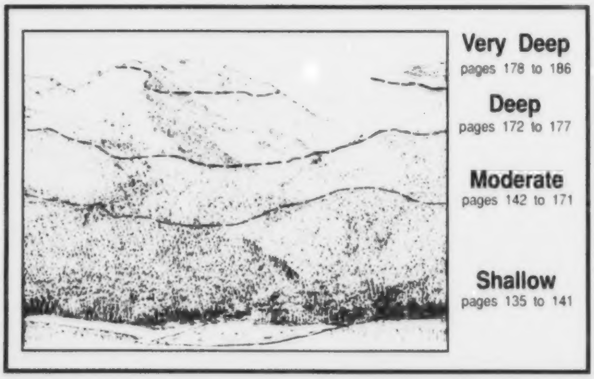


Figure 91. A schematic diagram of the snowpack zones and the pages pertaining to each zone in this chapter.

So that deer and elk habitat management can be coordinated as much as possible, the two ungulate species are treated together in most sections of this chapter. To simplify the factors that managers must consider, the distance-to-cover relations for each species (described in Chapters 2 and 3) have been combined. The slight loss in accuracy this entails is felt to be justified by the ease of application it allows.

The chapter is designed so that complete packages of information are provided for each seasonal range (or combination of seasonal ranges in the case of the shallow snowpack zone) within the shallow, moderate and very deep snowpack zones. Because management strategies and techniques for the deep snowpack zone are very similar to those described for the moderate snowpack zone, only the differences between these two are discussed in the deep snowpack zone section, and the reader is referred to the moderate zone for details.

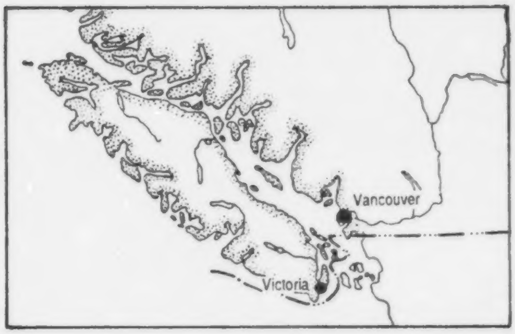
A suggested process for applying information from this chapter in planning programs of timber and habitat management is described in Chapter 6, "Applying the Handbook to Habitat Management Planning."

Working Tip: *To use Chapter 5, turn to the section that deals with the snowpack zone in which your management area lies. Read the introductory page for that snowpack zone to review the habitat concerns that are most important there. Then, for each seasonal range that requires special management attention, refer to:*

1. *the page describing common habitat problems, requirements, and management options;*
2. *the habitat management example;*
3. *the landscape illustration; and*
4. *the summary of habitat management techniques.*

These pages describe the principles and habitat-animal relationships most important for you to consider. Refer to the table(s) at the end of the chapter for information on the effects of the specific forest management practices that you may consider using.

APPLYING TECHNIQUES IN THE SHALLOW SNOWPACK ZONE



Shallow Snowpack Zone Characteristics

Elevation: usually between sea level and 300 m

Maximum snow depths: usually <30 cm; lasting less than 2 weeks

Frequency of critical snowpacks (depth of snow ≥45 cm for ≥30 days): one per 15 or more years

The shallow snowpack zone covers the coastal areas of Vancouver Island, the mainland, and the smaller islands, usually between sea level and 300 m elevation (Figures 14 and 92). The climate is mild, winters are mostly snow-free, and most deer and elk are resident year-round in small home ranges.

Virtually all of the shallow zone has good potential for habitat management. As a result of the mild winters, it has the highest capability of any snowpack zone for sustained, long-term production of deer. Deer and elk habitat has not been a concern to landowners, however, in the large blocks of private land on southeastern Vancouver Island and the Lower Mainland. Furthermore, even though public forest land has good potential to provide the necessary forage and cover conditions, present habitat suitability is only fair because extensive tracts of dense young coniferous forests are common. These forests provide good security and thermal cover but little forage.

On the following pages, you will find information on the common habitat problems and opportunities in the shallow snowpack zone, the forage and cover patterns required to provide adequate habitat during the three seasons, an example of habitat management, and common techniques used in the zone.

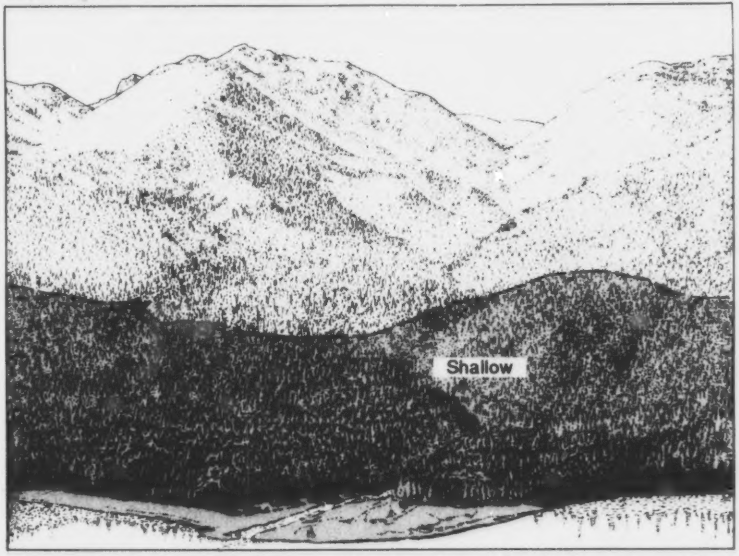


Figure 92. A schematic diagram of the location of the shallow snowpack zone.

Managing All Seasonal Ranges in the Shallow Snowpack Zone

What are the common habitat problems?

The most important problem in the shallow snowpack zone is the shortage of areas producing large amounts of high-quality forage. Closed-canopy forests provide good cover for all seasons, but the productivity of deer and elk herds is now restricted by poor food resources (Figure 93).

What is required?

Because most deer and elk reside in relatively small home ranges in this zone, they need to find food and cover for all seasons within small areas. Many areas have an overabundance of cover, and some of the dense young stands could be treated so that they also provide forage. This could be done by either:

1. harvesting and burning a series of cutblocks to ensure a continuous supply of forage in early successional stages (Figure 94a); or
2. heavily thinning one or more stands (Figure 94b), thinning stands more lightly but repeatedly, or maintaining existing openings within stands.

The first option is probably most feasible because many low-elevation forests in this zone are near or past rotation age. In this way, logging can be dispersed over large areas to produce a diverse mosaic of cover and forage. The second option is less commonly used because many young forests have already lost most of their understory vegetation, and thinning such stands will rarely result in re-establishment of preferred forage species.

Where and how can stands be managed?

The greatest forage benefit results from the logging or thinning of sites which have understory types that can produce abundant forage used in all seasons (e.g., the Sword fern type). Some treatment areas should be located on south slope sites with good winter and spring forage potential, but management of other topographic positions and other understory types is still beneficial.

The next four pages are designed to help you decide where and how to manage habitat for all seasons in the shallow zone. An example on the opposite page explains one possible approach for managing all seasonal habitats; suggests a sequence for determining treatments; and shows you where to find relevant information. A two-page landscape illustration follows, showing a desirable distribution of forage and cover areas. Finally, techniques available for managing habitat in the shallow zone are explained on page 140.

All Seasonal Ranges Parameters

Slope: all slopes

Aspect: all aspects (but winter and spring forage best on 90-270°)

Special considerations: none

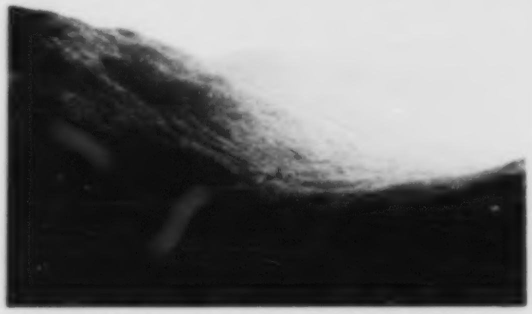


Figure 93. Extensive dense young forests restrict forage production.

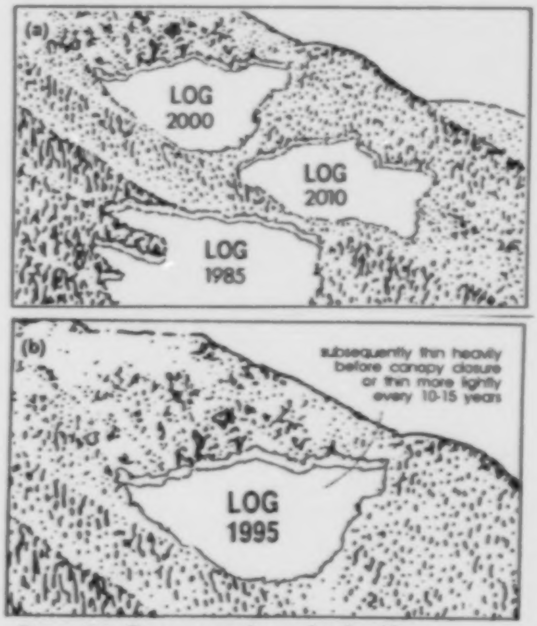
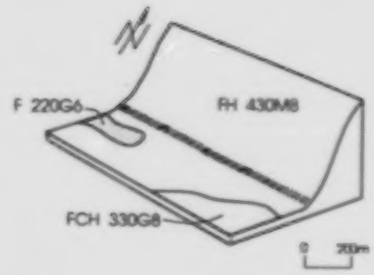

(a)
LOG 2000
LOG 2010
LOG 1985
(b)
subsequently thin heavily before canopy closure or thin more lightly every 10-15 years
LOG 1995

Figure 94. Forage may be maintained by sequential harvests (a), by a single heavy thinning, or by repeated lighter thinnings (b).

An Example of Habitat Management for All Seasons

Objective: To provide a balance of winter, spring, and summer habitats in close proximity



FIRST: ***Identify habitat problems and opportunities (using the next two pages).***

Forest type:

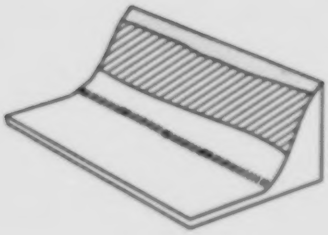
- Young-growth Douglas-fir (F 220G6 type on forest cover maps*)
- Douglas-fir, western hemlock, and redcedar (FHC 330G8 type)
- Douglas-fir and western hemlock (FH 430M8 type)

Successional stages:

○ Sapling - Pole with a crown closure of 60%
○ Young/Mature Timber with a crown closure >70%

Habitat problem:

Forage is extremely limited, except in the small area of F 220G6, for both deer and elk during all seasons.



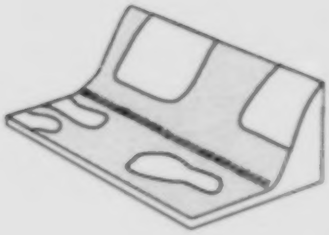
SECOND: ***Map understory types, special habitats, and known elk calving areas (using the next two pages and Appendix 1 [pp. 239]).***

Understory types:

○ Lichen - Salal understory type (moderate potential for winter deer forage)
▨ Moss - Dull Oregon-grape understory type (moderate potential for spring and summer deer forage)
○ Sword fern understory type (high potential for forage for both species in all seasons, except moderate for deer in winter)

Special habitats and elk calving areas:

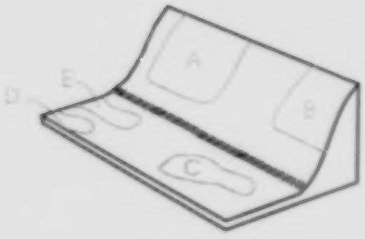
- None



THIRD: ***Determine desired forage and cover pattern (using the following two pages).***

The south slope area offers an opportunity to provide forage for both deer and elk on understory types that have good forage potential for winter and spring. The balance of the area can be managed to emphasize cover and summer forage.

○ Forage area
○ Security and thermal cover area



FOURTH: ***Determine treatments (using the next two pages and the "Techniques for Managing Forage" table on page 190).***

Habitat management strategy:

Thin young stands that still have abundant understory vegetation to maintain forage production. Sequentially harvest older stands, then thin selected regenerating areas on the south-facing slope for sustained winter and spring forage.

Treatments:

Year 1 - Thin the Sapling - Pole stand (area "E") to 400-600 stems/ha for forage.
- Harvest cutblocks in the Young/Mature Timber successional stage (areas "A"-"D") to provide abundant forage in all seasons.

Year 13 - Thin forage areas "A" and "B" on the south-facing slope to 400-600 stems/ha to maintain forage.

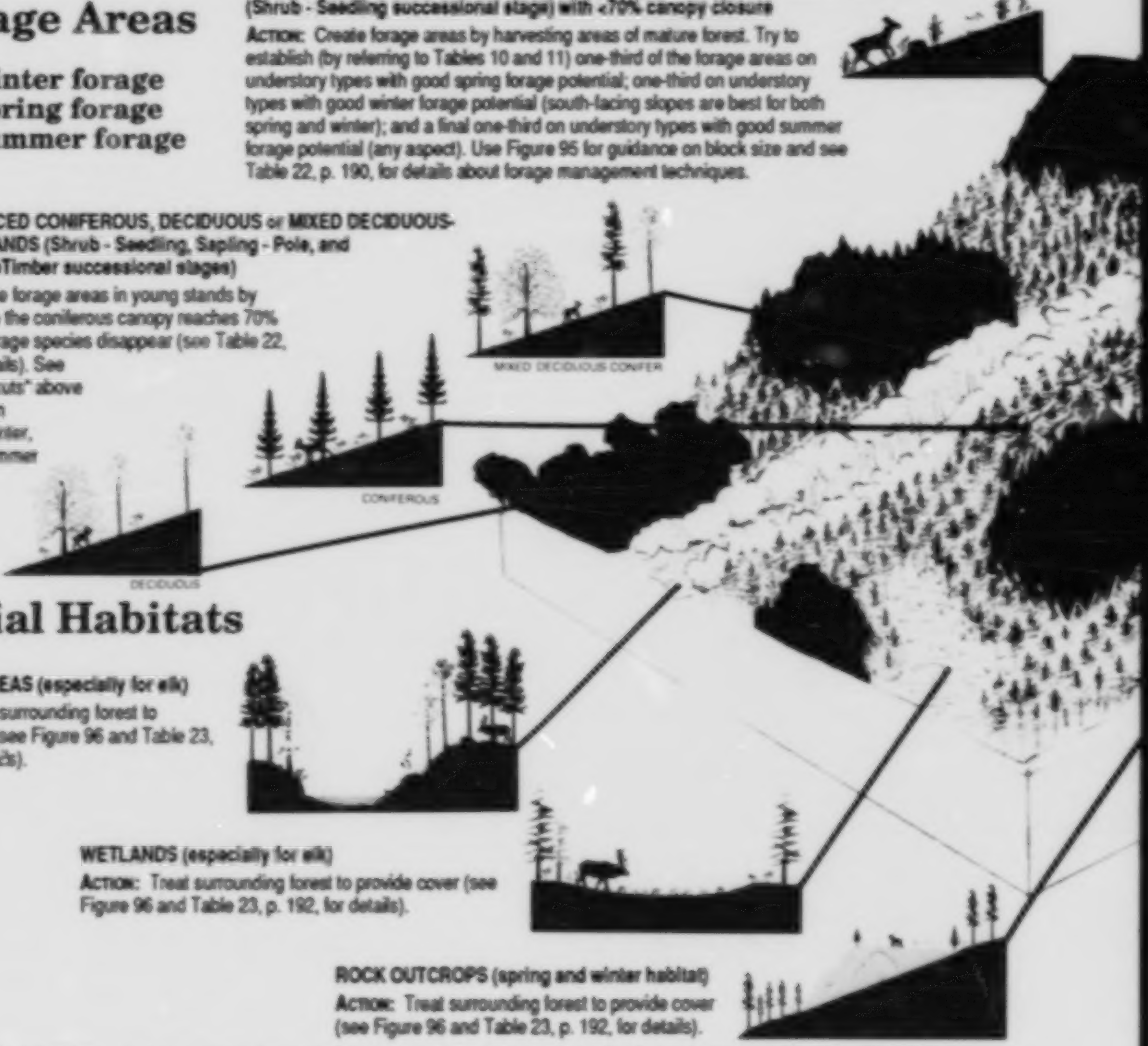
Year 25 - Continue to thin forage areas "A" and "B" on the south-facing slope to maintain winter and spring forage for deer.
- As regenerating stands on the Sword fern understory type meet the criteria for security and thermal cover but lose forage species, harvest adjacent timber to provide forage.

---

* The codes for forest cover types are explained in Appendix 5 (p. 283).

Distribution of Forage and Cover for Deer and Elk on All Seasonal Ranges

Optimally, forage areas no more than 400 m wide would be interspersed with cover areas 100 - 500 m wide (see Figures 95 and 96 below). Since non-migratory animals use the same area year-round, forage for all seasons should be provided. Treat the appropriate understory types (Tables 10 and 11 below) and create a patchwork of stands with open and closed canopies.



Forage Areas

- ☐ Winter forage
- ☐ Spring forage
- ■ Summer forage

RECENT CLEARCUTS (Herb successional stage) and REGENERATING STANDS (Shrub - Seedling successional stage) with <70% canopy closure

Action: Create forage areas by harvesting areas of mature forest. Try to establish (by referring to Tables 10 and 11) one-third of the forage areas on understory types with good spring forage potential; one-third on understory types with good winter forage potential (south-facing slopes are best for both spring and winter); and a final one-third on understory types with good summer forage potential (any aspect). Use Figure 95 for guidance on block size and see Table 22, p. 190, for details about forage management techniques.

WIDELY SPACED CONIFEROUS, DECIDUOUS or MIXED DECIDUOUS-CONIFER STANDS (Shrub - Seedling, Sapling - Pole, and Young/MatureTimber successional stages)

Action: Create forage areas in young stands by thinning before the coniferous canopy reaches 70% closure and forage species disappear (see Table 22, p. 190, for details). See "Recent Clearcuts" above for guidance on establishing winter, spring, and summer forage areas.

Special Habitats

RIPARIAN AREAS (especially for elk)

Action: Treat surrounding forest to provide cover (see Figure 96 and Table 23, p. 192, for details).

WETLANDS (especially for elk)

Action: Treat surrounding forest to provide cover (see Figure 96 and Table 23, p. 192, for details).

ROCK OUTCROPS (spring and winter habitat)

Action: Treat surrounding forest to provide cover (see Figure 96 and Table 23, p. 192, for details).

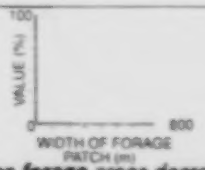


Figure 95. Open forage areas decrease in value to deer and elk as width increases above 120 m.

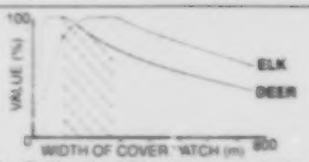


Figure 96. Optimal width of cover areas ranges from 100 to 500 m.

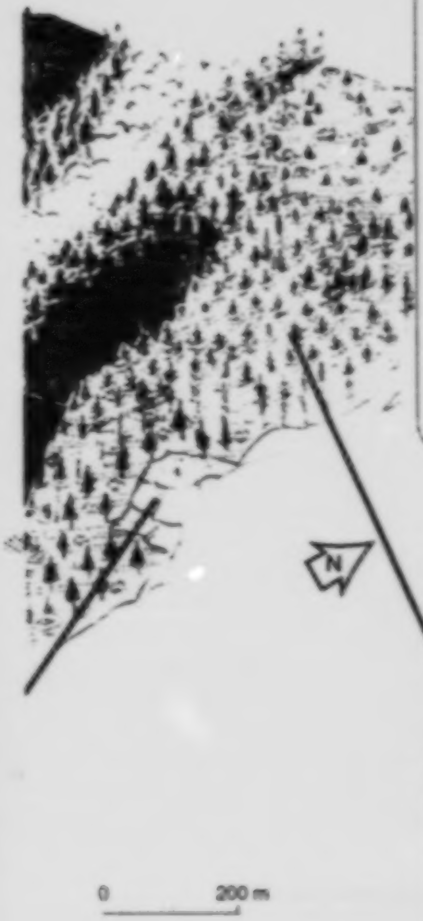
Good **forage** is produced in:

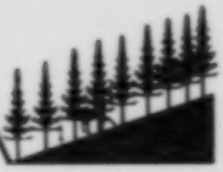
- recent clearcuts,
- open forests (crown closure <70%), with understory types providing preferred forage species (see Tables 10 and 11), and
- the special habitats shown in the diagram.

Security cover is provided by most fully stocked forests ≥2 m high (deer) or ≥3 m high (elk). These stands also provide thermal cover suitable for most weather conditions. To provide thermal cover for the most adverse conditions, stands ≥10 m high and ≥70% crown closure should make up ≥10% of the cover area.

How to Use this Information

1. Identify southerly aspects having understory types with good winter and spring forage potential in your area (see Tables 10 and 11 below).
2. Identify locations of any special habitats identified in the diagram and determine how you will manage them. (In most cases, simply protect them and provide adjacent cover.)
3. Compare the location and pattern of forage and cover areas in your area to the "ideals" indicated by the information on these two pages or the objectives for the area. Are significant improvements possible?
4. Decide whether further forage or cover areas are required to bring your area to the desired interspersion of forage and cover (use Figures 95 and 96 for guidance). If so, implement forage treatments on understory types with good forage potential and take advantage of natural openings wherever feasible.
5. In consultation with the Ministry of Environment, identify locations of elk calving areas. Minimize activity in these areas between 15 May and 15 July.
6. Decide on specific actions by referring to the tables at the end of the chapter, which describe techniques for managing forage and cover and outline how different successional stages can be treated.





Cover Areas

DENSE CONIFEROUS STANDS

Deer: (All successional stages except Herb) ≥2 m high.

Elk: (All successional stages except Herb and Shrub - Seedling) ≥3 m high.

Both: Some scattered stands, making up ≥10% of the cover area, ≥10 m high with canopies ≥70% closed for thermal cover.

ACTION: Treat so that vegetation is kept dense enough year-round to hide 90% of a deer or elk at ≤60 m (on average) throughout the stand. In addition, maintain interspersed thermal cover. See Table 23, p. 192.

Table 10. Understory types with good forage potential for deer (see Appendix 1)

WINTER	SPRING	SUMMER
Deer fern	Brome	Deer fern
Lichen - Prince's pine	Deer fern	Huckleberry - Moss
Lichen - Salal	Huckleberry - Moss	Moss - Dull Oregon-grape
Salal - Dull Oregon-grape	Moss - Dull Oregon-grape	Oak fern
Salal - Huckleberry	Oak fern	Ocean-spray - Tall Oregon-grape
Salmonberry - (Devil's club)	Salal - Dull Oregon-grape	Salal - Dull Oregon-grape
Skunk cabbage	Salal - Huckleberry	Salal - Huckleberry
Sword fern	Salmonberry - (Devil's club)	Salmonberry - (Devil's club)
	Skunk cabbage	Skunk cabbage
	Sword fern	Sword fern

Table 11. Understory types with good forage potential for elk (see Appendix 1)

WINTER	SPRING	SUMMER
Deer fern	Deer fern	Deer fern
Huckleberry - Moss	Huckleberry - Moss	Huckleberry - Moss
Salal - Dull Oregon-grape	Salmonberry - (Devil's club)	Salmonberry - (Devil's club)
Salal - Huckleberry	Skunk cabbage	Skunk cabbage
Salmonberry - (Devil's club)	Sword fern	Sword fern
Skunk cabbage		
Sword fern		

Techniques for all seasonal ranges in the shallow snowpack zone

The techniques most commonly used in this snowpack zone to improve habitat for all seasonal ranges focus on treating Young/Mature Timber successional stage stands to produce and maintain forage. Treatments may be applied to improve cover in areas where extensive logging has recently occurred.

Forage Techniques

- Clear-cut narrow blocks (<400 m wide) on appropriate understory types.
- Control debris depth.
- Encourage herbs on some blocks with spring understory types by:
    1. burning to reduce dense shrubs where they persist after logging, or
    2. scarifying to expose mineral soil.
- To increase forage further, consider seeding cutblocks and roadsides with grasses and herbs (see Chapter 4, p. 127).
- Once cutblocks are regenerated, limit herbicide application to spot treatments around crop trees.
- Thin to maintain <70% canopy closure if forage species are still abundant in the understory of the stand.
- Cut back and top shrubs and small western redcedar over 2 m high to a height of <1 m to increase forage.

Figure 97. See the "Techniques for Managing Forage" table, p. 190, and the "Techniques for Managing Security and Thermal Cover" table, p. 192, to determine measures for successional stages.

Security and Thermal Cover Techniques

To prepare for future cover areas:

- Harvest narrow blocks (100-500 m wide).
- Maintain, wherever possible, advanced coniferous regeneration (especially shade-tolerant species such as western redcedar and western hemlock).
- Maintain cover adjacent to special habitats.
- Control debris depth.
- Maintain soil conditions suitable for shade-tolerant species by avoiding hot broadcast burns and widespread scarification.
- Plant or regenerate naturally to >500 stems per hectare. Include, whenever possible, shade-tolerant species such as western redcedar and western hemlock as part of the species mix.
- When thinning, choose stands, whenever possible, that have a substantial component of western redcedar and western hemlock. These shade-tolerant species should ideally constitute >10% of the overstory after treatment.

Summary of the Shallow Snowpack Zone

Deer and elk: all seasons

SEASONAL RANGE LOCATIONS

- Snow depths do not restrict access to food, so winter, spring, and summer ranges often overlap.

COMMON HABITAT PROBLEMS

- Forage is limited by dense coniferous forests.

HABITAT MANAGEMENT EMPHASIS

- Focus efforts on producing forage on appropriate understory types with cover nearby.
- Treat winter and spring understory types on south-facing slopes whenever possible.

COMMON HABITAT MANAGEMENT TECHNIQUES

- Forage can be provided either by clearcutting or thinning. Clearcutting is most appropriate for re-establishing forage species, as most of these have disappeared in dense young forests. Subsequent thinning of new stands to maintain forage is important when future clearcuts are not planned.

CAUTIONS

- Ensure adequate security and thermal cover are present next to planned forage treatment areas.
- When possible, before deciding where to locate treatment areas, identify elk calving areas and protect them from disturbance (between May 15 and July 15).
- Protect special habitats (especially wetlands) from disturbance by siting roads and harvesting activities well back from these habitats, and maintaining a visual screen.

APPLYING TECHNIQUES IN THE MODERATE SNOWPACK ZONE

The moderate snowpack zone usually lies between 200 and 600 m elevation, and forms a zone of transition between the coastal and mountainous areas (Figures 14 and 98). Snow depths in this zone significantly influence habitat use, hence the proportion of migratory deer and elk is higher than in the shallow snowpack zone.

Deer and elk habitat capability is high. The current mosaic of virgin forests, regenerating stands, and recently logged areas provides a good mix of habitats, but the rapid rate of harvest in old-growth winter ranges and the regeneration of stands to dense young-growth are matters of concern to habitat managers.

South-facing slopes assume greater importance in the moderate zone than in the shallow zone because they provide warmer winter temperatures and shallower snow than other sites. Habitat management plans must recognize the special value of south slopes, especially for migratory elk (which may travel 10-40 km to summer range) and deer. During a mild winter, resident animals will thrive in suitable habitats on other sites. These differing concerns for resident and migratory animals make habitat management more complicated here than in the shallow zone.

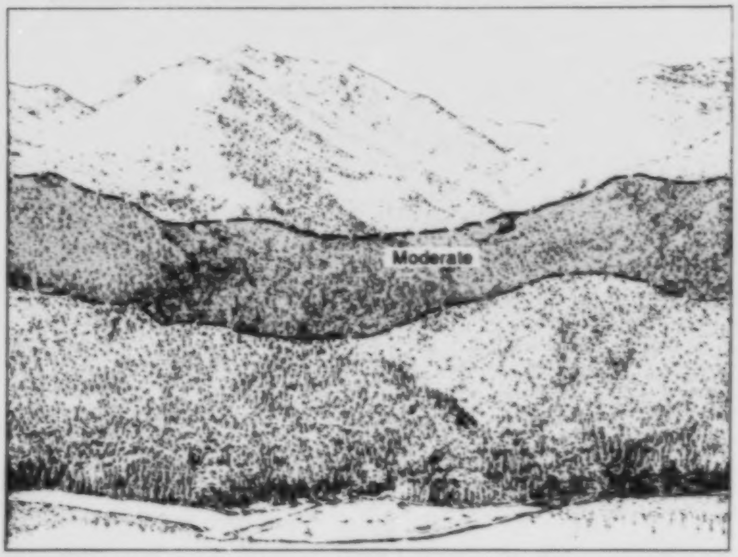
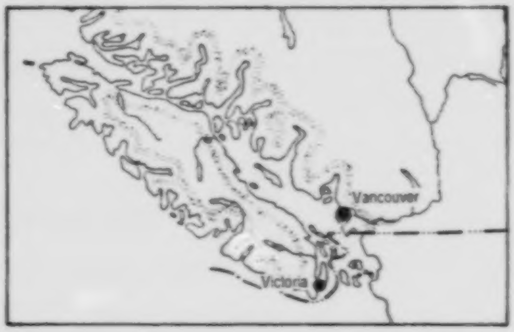


Figure 98. A schematic diagram of the location of the moderate snowpack zone.

On the following pages, for each seasonal range, common habitat problems and opportunities are described, desirable forage and cover patterns are explained, an example of habitat management is shown, and common techniques are outlined.



Moderate Snowpack Zone Characteristics

Elevation: usually between 200 and 600 m

Maximum snow depths: usually 30-60 cm; lasting up to 2 weeks

Frequency of critical snowpacks (depth of snow ≥45 cm for ≥30 days): one per 5-15 years

Managing Deer Winter Range in the Moderate Snowpack Zone

What are the common habitat problems?

Many potential winter ranges for deer in the moderate snowpack zone lack good habitat because past logging removed most of the virgin forests. Since the clearcuts and dense young forests regenerated after logging seldom provide adequate forage combined with snow interception cover and security cover (Figure 99), many deer succumb during harsh winters. In addition, many potential critical winter ranges lack adequate spring ranges nearby.

What is required?

When snow is deep (>30 cm), deer need habitat that is on south-facing slopes and that provides a mix of both closed and open snow interception cover, scattered small openings for forage production and solar exposure, and coniferous thickets for security and thermal cover (Nyberg *et al.* 1986). Most old-growth forests provide this mix naturally, and it may also be possible that young forests can be managed to provide the same benefits (Figure 100).

Since winter range creation in young forests is still being studied and results are not yet available, old-growth retention is still the best option for maintaining deer populations.

Where and how can stands be managed?

Where old growth is not available or management of young stands is a priority, winter habitat creation should be planned on suitable topographic sites (see sidebar) with understory types having high potential for winter forage production.

The next six pages are designed to help you decide where and how to create critical winter range in young forests. An example shown overleaf depicts one possible approach for managing winter range habitat, suggests a sequence for determining treatments, and shows the location of relevant information within the handbook. A two-page landscape illustration follows, showing the desired distribution of forage and cover areas. Finally, techniques suitable for creating critical winter habitat are explained on page 148.

Critical Winter Range Topographic Parameters for Deer

Elevation: <1000 m
Slope: ≥40%
Aspect: 110-250°
Special considerations: receives winter sun; spring range ≤2 km away

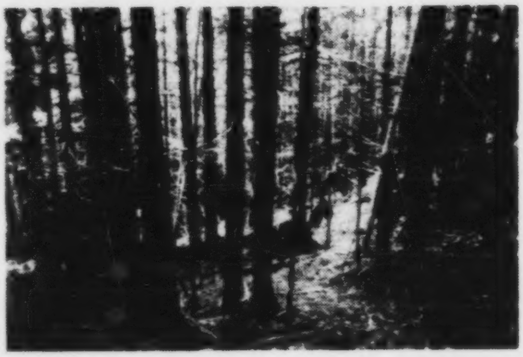


Figure 99. Dense young forests provide inadequate forage and cover.

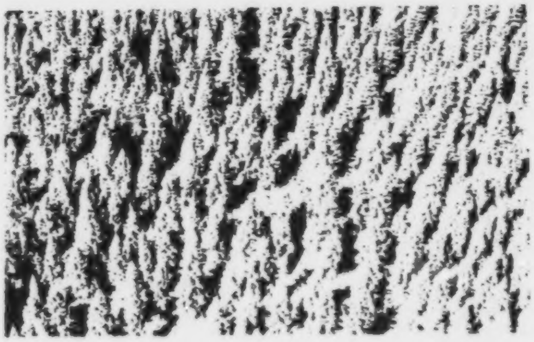
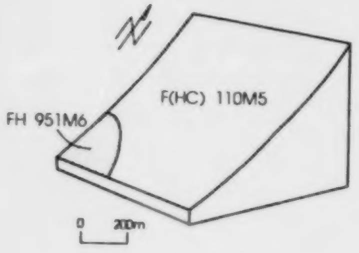


Figure 100. Winter range created in young stands may replace old-growth ranges to be harvested in future.

An Example of Creating Critical Winter Range for Deer

Objective: To provide critical winter range in young stands so that deer can survive deep, long-lasting snow


N
F(HC) 110M5
FH 951M6
0 200m

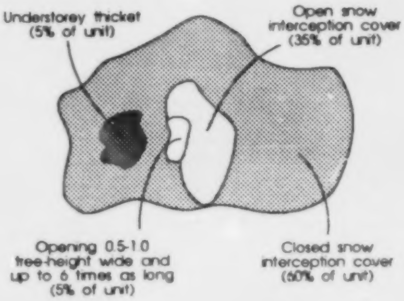
FIRST: ***Select an area with suitable topography and stand conditions (see pp. 146-147).***

Topography:

A moderately steep (45-65%) south-west facing slope at an elevation of 550 m. Shaded by nearby mountains only in early morning.

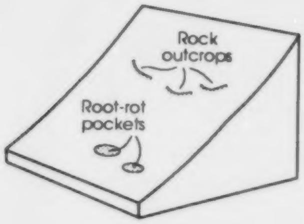
Stand:

A 15-year-old stand dominated by Douglas-fir, with some western hemlock and western redcedar (F[HC] 110M5 type*). The canopy is fairly open (55-65% canopy closure), forage shrubs are abundant, and arboreal forage lichen is abundant in nearby old growth (FH 951M6 type).


Understorey thicket (5% of unit)
Open snow interception cover (35% of unit)
Opening 0.5-1.0 tree-height wide and up to 6 times as long (5% of unit)
Closed snow interception cover (60% of unit)

SECOND: ***Calculate appropriate sizes for openings and associated cover and thickets (see pp. 146-147).***

Trees are expected to be 30-35 m tall during the last half of the rotation, so openings should be 15-35 m wide and 15-210 m long—thus one-fiftieth to three-quarters of a hectare in area. Openings make up 5% of each cover-thicket-opening unit, so units can be approximately two-fifths to 15 ha in size. Several small cover-thicket-opening units (those less than 5 ha) would need to be grouped to provide an effective block of critical winter range.


Rock outcrops
Root-rot pockets

THIRD: ***Identify locations for openings and associated cover and thickets (see pp. 146-147).***

Natural openings, such as those on rock outcrops or where root rot has killed trees, are obvious candidates for permanent openings. Snow interception cover and thickets should be planned around these openings and other openings should be created to bring the total area of openings to approximately 5% of the winter range.

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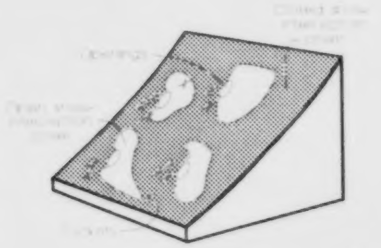
* The codes for forest cover types are explained in Appendix 5 (p. 293).



FOURTH: ***Prescribe treatments for each habitat component (see pp. 146-147) and the "Techniques for Managing Snow Interception Cover" table (p. 194).***

Openings:

- Clear all trees to promote maximum solar exposure and understory growth.

Thickets:

- Maintain a component of western hemlock and western redcedar in the overstory to provide a seed source for understory thickets.

Closed snow interception cover:

- Thin initially to ~500 trees/ha to maintain abundant understory and promote rapid growth of large-crowned trees (Figure 101).
- Thin again as required to maintain canopy closure at <70% until trees intercept heavy snow effectively.
- Thin sequentially as required to maintain canopy closure at 70-90% while the area is functioning as winter range.

Open snow interception cover:

- Thin initially to ~500 trees/ha.
- Thin again as required to maintain canopy closure at <70% until trees intercept heavy snow effectively.
- Thin subsequently as required to maintain canopy closure at 60-70% while the area is functioning as winter range.

Figure 101. A winter range creation trial on southern Vancouver Island.

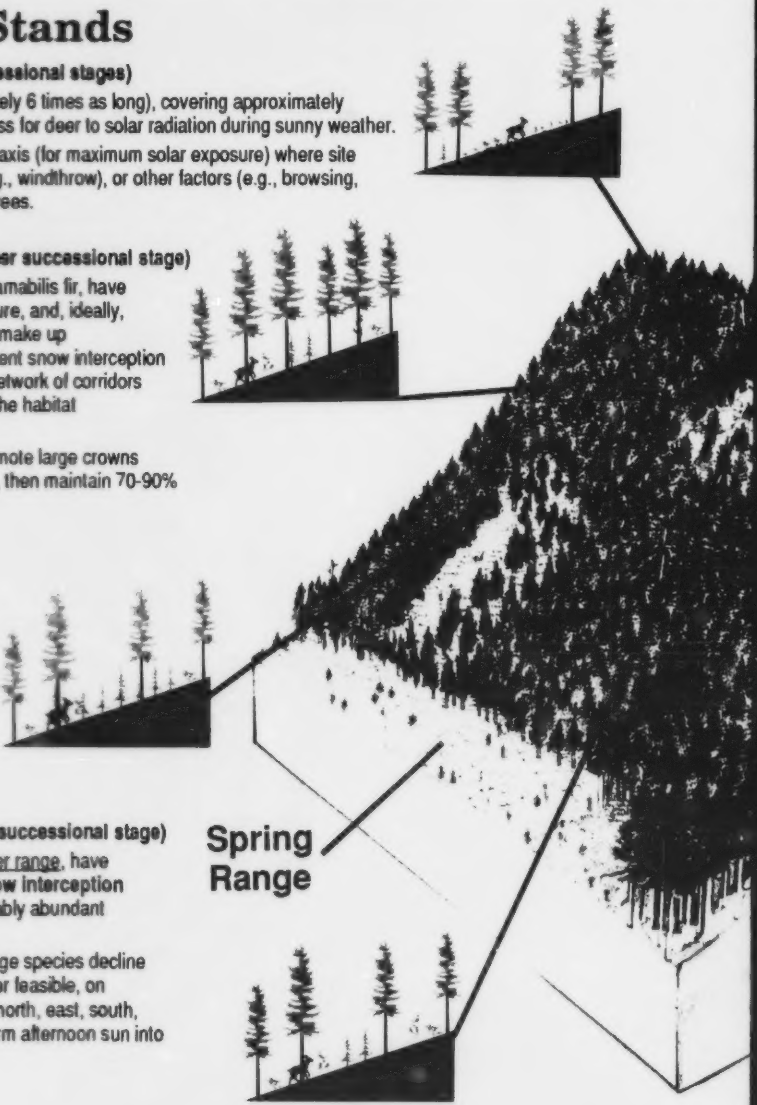
Distribution of Winter Habitat for Deer in Young Stands

For young forests[13] to provide critical winter range, they should contain a fine-grained mosaic of **open and closed snow interception cover** (with arboreal lichen), scattered small **openings**, and coniferous **thickets**.

To function effectively, each opening must have adjacent both open and closed snow interception cover (with thickets) as depicted in the diagram.

To provide critical winter range continuously, treatment areas should be "twinned." Thus, once the

Young Conifer Stands



Scattered small OPENINGS (Herb and Shrub - Seedling successional stages)

These small areas (0.5-1.0 tree-height wide and up to approximately 6 times as long), covering approximately 5% of the managed winter range, provide rooted forage and access for deer to solar radiation during sunny weather.

ACTION: Where possible, establish openings along a north-south axis (for maximum solar exposure) where site conditions (e.g., rock outcrops, root-rot infection), disturbance (e.g., windthrow), or other factors (e.g., browsing, vegetative competition) have reduced stocking or site quality for trees.

CLOSED SNOW INTERCEPTION COVER (Young/Mature Timber successional stage)

These areas, comprising chiefly Douglas-fir, western hemlock or amabilis fir, have large-crowned trees greater than 10 m high, 70-90% canopy closure, and, ideally, abundant arboreal lichen. Closed snow interception cover should make up approximately 60% of the managed winter range, providing excellent snow interception and overhead thermal cover plus some shrubs. It should form a network of corridors with reduced snow depth to allow easy deer movement between the habitat components noted below.

ACTION: Thin young stands early to < 70% canopy closure to promote large crowns and maintain understory forage (see Table 24, p. 194, for details), then maintain 70-90% canopy closure while the area functions as winter range.

Scattered CONIFEROUS THICKETS

These areas (minimum 30 m diameter), covering at least 5% of the managed winter range, provide thermal and security cover (≥2 m high, sufficient to hide 90% of a deer at ≤60 m, on average, throughout the thicket) within the snow interception cover.

ACTION: Establish thickets, whenever possible, within closed snow interception stands adjacent to openings. This will place the best security cover close to the prime foraging areas.

OPEN SNOW INTERCEPTION COVER (Young/Mature Timber successional stage)

These areas, making up approximately 35% of the managed winter range, have 60-70% crown closure but are otherwise similar to the **closed snow interception cover** (see above). They provide good snow interception, reasonably abundant understory forage, and, ideally, arboreal lichen forage.

ACTION: Thin before canopy closure reaches 70% and winter forage species decline (see Table 24, p. 194, for details). Establish these areas, whenever feasible, on understory types with good forage potential (see Table 14) to the north, east, south, and southwest of openings to ensure maximum penetration of warm afternoon sun into both the openings and these forage-producing stands.

Table 12. Location criteria for treatment areas

- elevation less than 1000 m
- southerly aspect (between 110 and 250°)
- receives winter sun (i.e., not shaded by adjacent mountains)
- slope greater than 40%
- within 400 m and, if possible, downwind of lichen-bearing stands
- close to spring range (see Table 13)
- preferably contains scattered lichen-bearing snags or veteran trees
- preferably on moderate to good growing site
- possesses some understory types with good winter forage potential (see Table 14)

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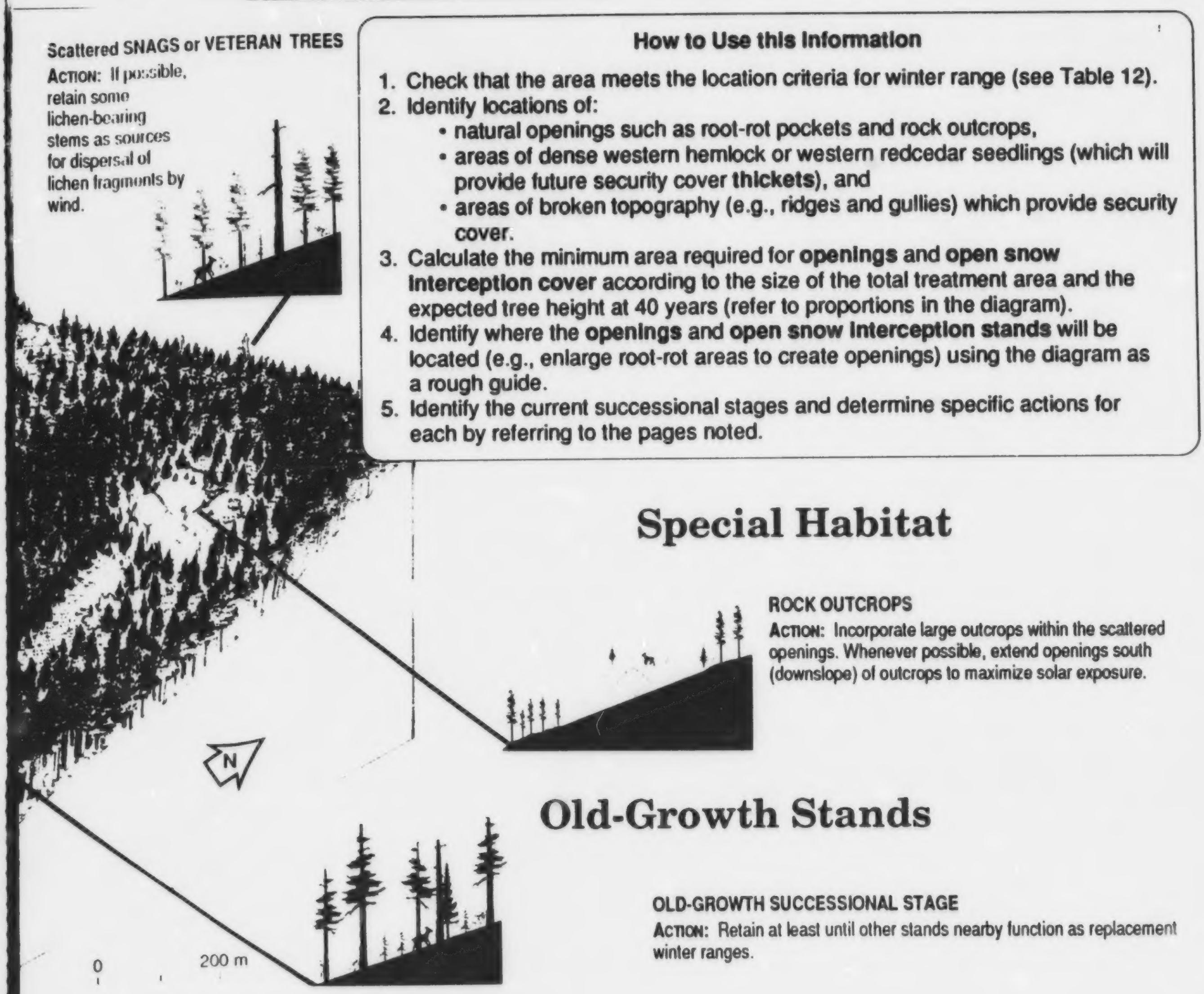
[13] These characteristics apply to habitat needed during severe winters and concern only stands on moderately steep, southerly slopes below 1000 m.

first treatment area begins to provide habitat that is useful during severe winters, the adjacent winter range could be harvested. With an 80-year rotation, for example, alternate blocks could then be logged at 40 year intervals. Because the creation of critical winter range for deer is still experimental, treatment areas should be monitored to evaluate their effectiveness in supporting deer during severe winters.



How to Use this Information

1. Check that the area meets the location criteria for winter range (see Table 12).
2. Identify locations of:
    - natural openings such as root-rot pockets and rock outcrops,
    - areas of dense western hemlock or western redcedar seedlings (which will provide future security cover **thickets**), and
    - areas of broken topography (e.g., ridges and gullies) which provide security cover.
3. Calculate the minimum area required for **openings** and **open snow interception cover** according to the size of the total treatment area and the expected tree height at 40 years (refer to proportions in the diagram).
4. Identify where the **openings** and **open snow interception stands** will be located (e.g., enlarge root-rot areas to create openings) using the diagram as a rough guide.
5. Identify the current successional stages and determine specific actions for each by referring to the pages noted.

Scattered SNAGS or VETERAN TREES

ACTION: If possible, retain some lichen-bearing stems as sources for dispersal of lichen fragments by wind.

Special Habitat

ROCK OUTCROPS

ACTION: Incorporate large outcrops within the scattered openings. Whenever possible, extend openings south (downslope) of outcrops to maximize solar exposure.

Old-Growth Stands

OLD-GROWTH SUCCESSIONAL STAGE

ACTION: Retain at least until other stands nearby function as replacement winter ranges.

Table 13. Optimum distance between winter and spring ranges

Immediately adjacent	Excellent
< 400 m	Good
400 m - 2.0 km	Fair
> 2.0 km	Poor

Table 14. Understory types with good winter forage potential for deer (see Appendix 1 for details)

Deer fern
Huckleberry - Rosy twistedstalk
Lichen - Falsebox
Lichen - Prince's pine
Lichen - Salal
Salal - Dull Oregon-grape
Salal - Huckleberry
Salmonberry - (Devil's club)
Skunk cabbage
Sword fern

Techniques for deer winter range in the moderate snowpack zone

Techniques for creating winter habitat in young forests are focussed on treating Sapling-Pole successional stages. Objectives are to produce and maintain forage (both rooted vegetation and arboreal lichen) and cover (snow interception, security, and thermal) within the same stand. Often this involves thinning stands on preferred understory types before rooted forage declines with the closure of the tree canopy. In some areas, however, where future winter habitat is desired, older stands which have lost rooted forage could be thinned and underplanted with forage species, then subsequently managed to produce winter habitat.

The main techniques are summarized below, but managers are encouraged to consult for details the landscape illustration on the two preceding pages and the "Techniques for Managing Snow Interception Cover" table at the end of this chapter (p. 194).

FORAGE TECHNIQUES

- Provide scattered openings 0.5-1.0 tree-height wide and up to 6 times as long on appropriate understory types by maintaining natural openings or clearcutting additional ones. Retain conifer thickets around these openings whenever possible for security cover.
- Cut back and top shrubs and small western redcedar >2 m high to a height of <1 m. This encourages sprouting and increases available forage.
- Limit herbicides to spot treatment around crop trees.

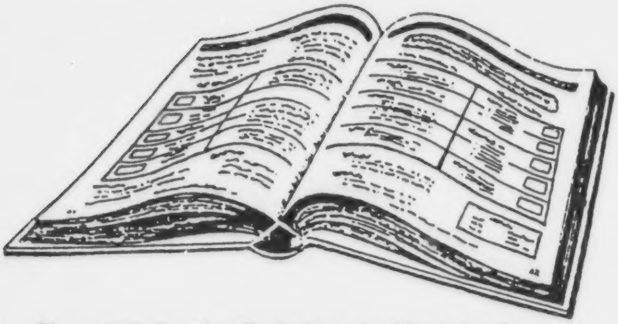


Figure 102. See the "Techniques for Managing Snow Interception Cover" table, p. 194, to determine measures for successional stages.

SNOW INTERCEPTION COVER TECHNIQUES

To treat younger stands which still support abundant understory vegetation:

- Thin before canopy closure first reaches 70%, to produce 60-70% closure in areas of open snow interception cover and 70-90% in areas of closed snow interception cover after the trees reach 10 m high.
- When thinning, aim for a final crop tree density of 150-300 crop trees per hectare to maximize crown volume of individual trees, unless snow interception is adequate at higher densities.
- Retain conifer thickets, especially around openings, and leave 10-15% western hemlock and/or western redcedar in the overstory for seed production to establish future thickets.
- If there is little winter security cover available (conifers with live branches at ground level), do not prune trees along edges of openings.
- Do not prune limbs above 3 m which support arboreal forage lichens.
- Consider fertilizing to promote rapid tree growth and understory productivity on nutrient-poor sites.

To treat Old Growth and older stands of Young/Mature Timber which have lost forage vegetation:

- Prepare for future snow interception cover by clearcutting areas of 5-80 ha. Avoid burning, if possible, to retain shrubs and maintain organic soil substrate for western hemlock and western redcedar. If these sites have been burned, consider managing them initially as spring forage areas.
- Maintain, wherever possible, advanced coniferous regeneration (especially shade-tolerant species such as western redcedar and western hemlock).
- Where climatic and edaphic conditions allow, plant Douglas-fir and a small proportion (10-15%) of western redcedar and/or western hemlock.

Managing Elk Winter Range in the Moderate Snowpack Zone

What are the common habitat problems?

Elk winter habitat has been affected by past logging activities in the same manner as deer winter habitat has, with the removal of old-growth forests restricting availability of suitable forage and cover areas. Little forage is available on some important winter ranges, as many of the resulting young forests have now formed dense canopies (Figure 103). The main habitat management priority is thus the provision of open forage areas adjacent to cover areas, ensuring a mix of snow interception, security, and thermal cover.

What is required?

Elk are less dependent than deer on forest stands to intercept snow and make forage available (see Chapter 3, pp. 74, 84). During severe winters, however, they still require snow interception cover close to forage areas.

Wintering elk are usually associated with two distinct topographic types: lowland gentle slopes and nearby upland south-facing slopes. The lowland gentle slopes ideally should provide a mix of forage and snow interception areas as shown in the landscape illustration (p. 154). Habitat requirements on upland south-facing slopes depend on the adequacy of snow interception cover on adjacent lowland areas. Thus, upland areas could be managed in one of two ways:

1. If snow interception cover is abundant on the lowlands (Scenario 1), no more is needed on the upland. In this case, upland south-facing slopes can be managed to provide a mix of forage and security and thermal cover areas (like spring range in this snowpack zone).
2. If snow interception cover is not abundant on the lowlands (Scenario 2), the uplands will have to supply it. In this case, the upland south-facing slopes should be managed to provide a mix of forage and snow interception cover areas.

Where and how can stands be managed?

Old-growth forests provide optimal snow interception, but it is also possible for young forests to provide suitable snow interception cover, especially at lower elevations. In most situations, managing small blocks is the best way to intersperse forage and cover areas through space and time (see p. 86 for details). Special habitats (rock outcrops, riparian areas, wetlands) should be protected from disturbance, with adjacent snow interception and/or security cover provided. Visual screens are generally required to buffer special habitats from human activity (e.g., main haul roads).

The next seven pages are designed to help you decide where and how to manage forest habitat on elk winter ranges. An example starting on the opposite page depicts one possible approach for managing winter range habitat, suggests a sequence for determining treatments, and shows the location of relevant information within the handbook. A graphic follows, illustrating the desirable distribution and type of forage and cover. Finally, techniques useful for managing winter habitat are explained on page 156.

Winter Range Parameters for Elk

Lowland Gentle Slopes

Slope: averages <10%
Aspect: all aspects, often on floodplains

Upland South-Facing Slopes

Slope: 10-50%
Aspect: 90-270°
Special considerations: receives winter sun

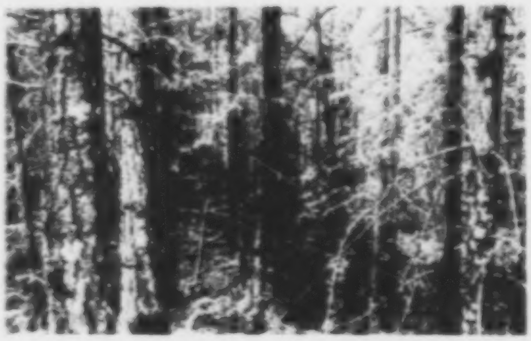
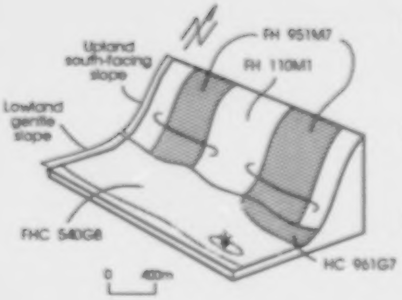


Figure 103. Extensive dense young forests provide inadequate forage and cover for elk.

An Example of Creating Winter Range for Elk

Objective: To provide winter habitat that allows elk to survive winters with deep, long-lasting snow



FIRST: ***Identify habitat problems and opportunities (using pp. 154-155).***

Lowland Gentle Slopes

Forest type:

- A uniform, thrifty stand of Douglas-fir, western hemlock, and redcedar (FHC 540G8*)
- A small area of old-growth western hemlock and redcedar (HC 961G7)

Successional stages:

○ Young/Mature Timber with a crown closure >70%

● Old Growth with variable (60-90%) crown closure

Habitat problem:

Forage is limited (Figure 104) except in the small area of old growth. All types of cover (security, thermal, and snow interception) are abundant.

Upland South-Facing Slopes

Forest type:

- Very immature Douglas-fir in recent clearcuts (F 110M1)
- Old-growth Douglas-fir and western hemlock (FH 951M7)

Successional stages:

○ Shrub - Seedling

● Old Growth with variable (60-90%) crown closure

Habitat problem:

Presently no problems; adequate forage and cover are available.

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* The codes for forest cover types are explained in Appendix 5 (p. 293).

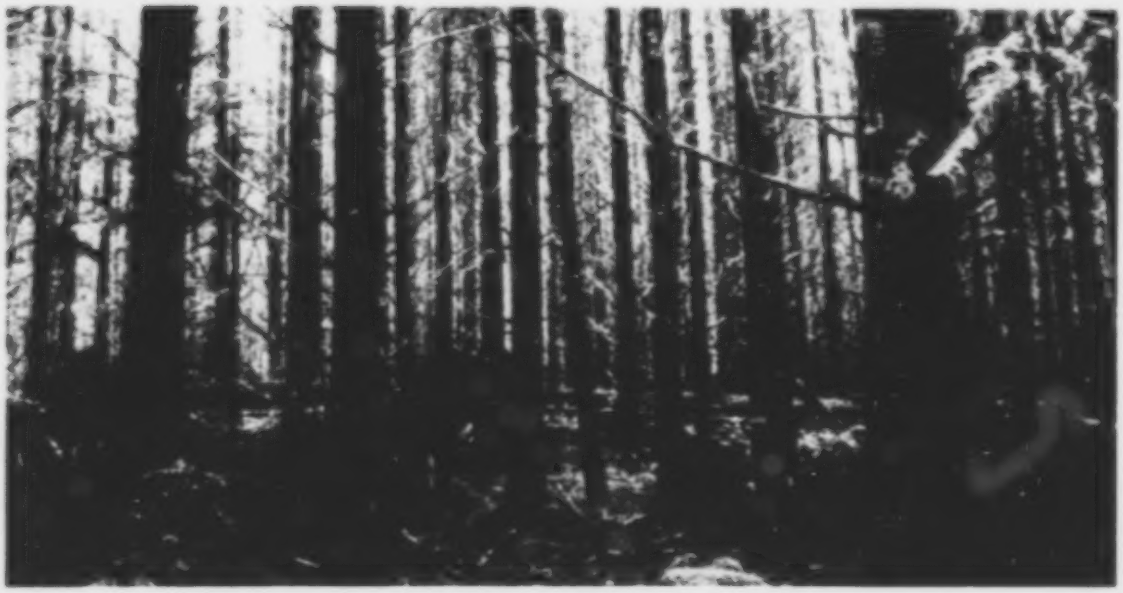
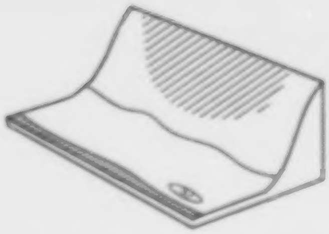


Figure 104. Young/Mature Timber with a closed canopy has very limited forage.



SECOND: ***Map understory types and special habitats (using pp. 154-155 and Appendix 1 [p. 239]).***

Lowland Gentle Slopes

Understory type:

- ○ Sword fern understory type (high forage potential)

Special habitats:

- ● Riparian
- ◍ Small wetland area

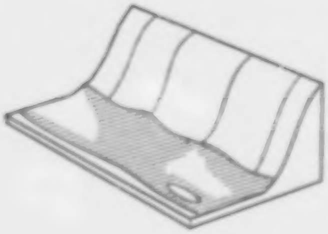
Upland South-Facing Slopes

Understory types:

- ⊘ Huckleberry - Moss understory type (moderate winter forage potential)
- ○ Moss understory type (low potential for forage)

Special habitats:

- None



THIRD: ***Determine desired forage and cover pattern (using pp. 154-155).***

Lowland Gentle Slopes

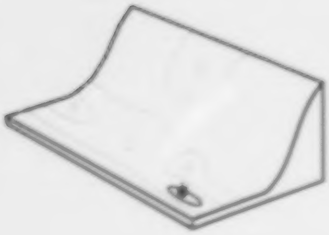
Although there is an abundance of snow interception cover on the lowlands, increased forage areas are required for elk to make full use of this important area.

- ○ Forage area
- ● Security, thermal, snow interception cover area

Upland South-Facing Slopes

The present successional stages provide an adequate forage and cover pattern. In future, since there is (and will be) adequate snow interception cover on the lowland gentle slopes, the cover areas on the upland south-facing slopes need only be managed for security and thermal cover (see Scenario 1 on p. 154). Future forage areas are best located on the Huckleberry - Moss understory type.

- ○ Forage area
- ○ Security and thermal cover area



FOURTH: ***Determine treatments (using the next two pages and the tables starting on p. 190).***

Lowland Gentle Slopes

Habitat management strategy:

Retain the small area of old growth to provide security cover, thermal cover, and snow interception cover. Clear-cut several small blocks in the younger forest to provide forage. Manage the balance of the younger forest to provide snow interception cover, especially around the special habitats.

Treatments:

Year 1 - Harvest areas "A" and "B" to enhance forage production while retaining adjacent cover. Protect cover areas surrounding the riparian and bog habitat (e.g., locate access roads away from these special habitats).
- Commercially thin the balance of the younger forest (area "C") to provide a mix of open and closed snow interception cover (refer to the "Techniques for Managing Snow Interception Cover" table, p. 194).

Year 13 - Thin forage areas "A" and "B" to 600 stems/ha to maintain forage (see "Techniques for Managing Forage" table, p. 190).

Year 25 - Thin some portions of the forage areas "A" and "B" to maintain forage.
- Thin other portions of the forage areas to provide a mix of open and closed snow interception cover (using "Techniques for Managing Snow Interception Cover" table, p. 194) so that the adjacent forest, in either area "C" or the old growth, can be harvested.

Upland South-Facing Slopes

Habitat management strategy:

Maintain forage on the Huckleberry - Moss understory type by thinning. When the security and thermal cover criteria have been met (see moderate snowpack zone - spring range, p. 160) in the present clearcut areas located on the Moss understory type, harvest some adjacent old growth.

Treatments:

Year 8 - Thin the Shrub - Seedling successional stage blocks on the Huckleberry - Moss understory type (area "D") to 600 stems/ha to maintain forage.

Year 15 - When security and thermal cover criteria have been met in the previously logged areas on the Moss understory type, some adjacent old growth can be harvested.

Year 25 - Continue to thin some areas on the Huckleberry - Moss understory type to maintain forage.

Distribution of Winter Habitats for Elk

On winter ranges, elk use two habitat types:

1. **lowland gentle slopes** that have forage areas interspersed with snow interception cover areas (see Figures 105 and 106 for "ideal" distances). These are valley bottom and coastal plain areas averaging less than 10% slope, especially river floodplains, riparian areas, or sites with rich, moist soils. Small areas of steeper terrain may be included.
2. **upland south-facing slopes** that have a

Lowland Gentle Slopes

Forage Areas

RECENT CLEARCUTS, REGENERATING STANDS, and WIDELY SPACED CONIFEROUS, DECIDUOUS or MIXED STANDS (all successional stages except Old Growth)

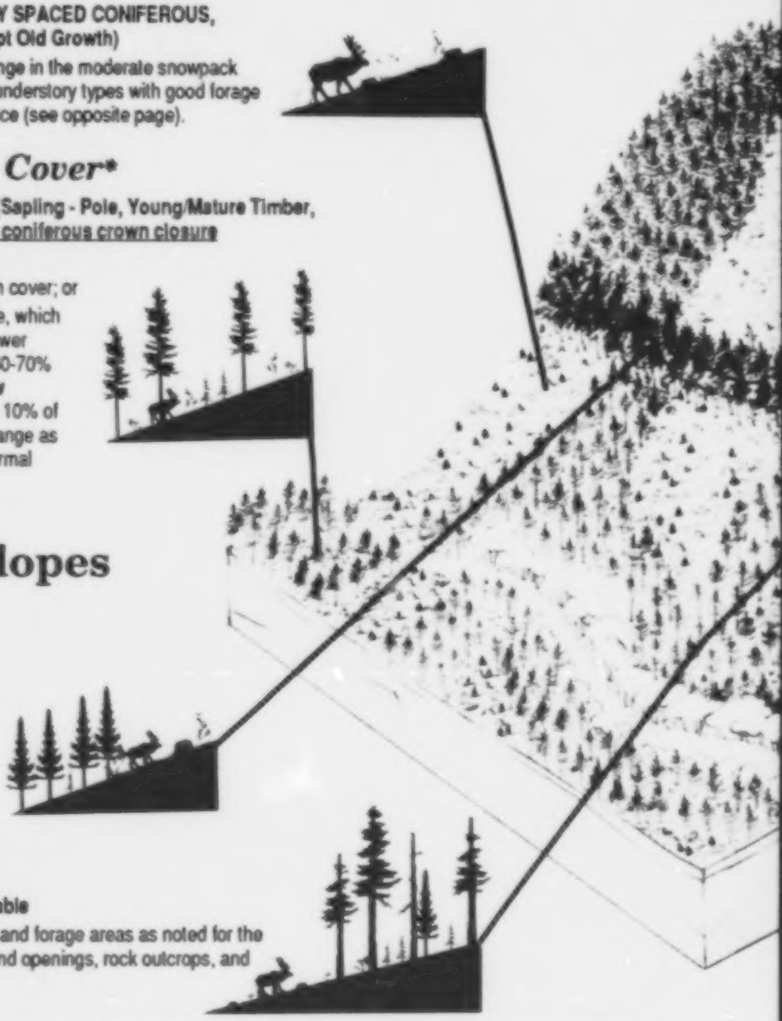
ACTION: Manage in the same way as for forage areas on spring range in the moderate snowpack zone (see pp. 160-161). Focus forage management efforts on the understory types with good forage potential (see Table 15) and protect special habitats from disturbance (see opposite page).

*Snow Interception Cover**

CONIFEROUS or MIXED DECIDUOUS-CONIFEROUS STANDS (Sapling - Pole, Young/Mature Timber, and Old Growth successional stages) ≥10 m high with 60-90% coniferous crown closure

ACTION: These areas can be managed in two ways:

1. Retain old growth, which provides optimal snow interception cover; or
2. Provide young stands ≥10 m tall with 60-90% crown closure, which provides adequate snow interception cover (especially at lower elevations of this zone). **Open snow interception cover** (60-70% closure) should dominate, but a component of **closed snow interception cover** (70-90% closure), consisting of at least 10% of the winter range area, is required to provide critical winter range as refuge from very deep snow. The latter will also provide thermal cover. See Table 24, p. 194, for details.



Upland South-Facing Slopes

Scenario 1

When lowland snow interception cover is abundant**

ACTION: Manage upland slopes using the same techniques (and forage and cover patterns) as described for spring range in the moderate snowpack zone (see pp. 158-162).

Scenario 2

When lowland snow interception cover is scarce or not available**

ACTION: Manage upland slopes to provide snow interception cover and forage areas as noted for the lowlands (see "Lowland Gentle Slopes" above). Provide cover around openings, rock outcrops, and wetlands (see opposite).

*Figure 105. Open **forage** areas decrease in value to deer and elk as width increases above 120 m.*

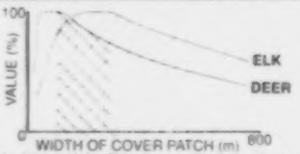


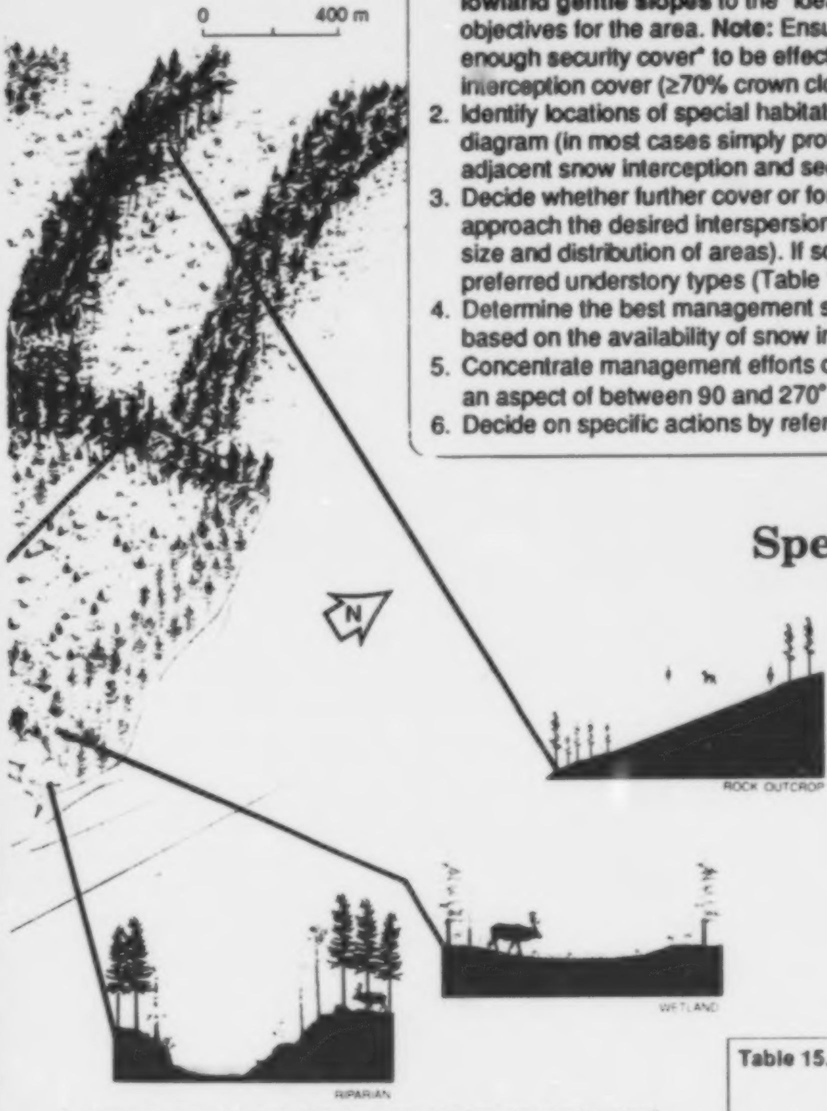
*Figure 106. Use this figure to determine width of **snow interception cover** treatment areas.*

mixture of cover and forage areas. These habitats are used for sunning and foraging during periods of snow melt in the winter.

Lowland gentle slope habitat will always be most valuable if managed to provide snow interception cover and forage. However, **upland south-facing slope** habitat can be managed in one of two ways (as shown below), depending on the abundance of snow interception cover on the lowlands.

How to Use this Information

1. Compare the distribution of open snow interception cover and forage areas on **lowland gentle slopes** to the "ideal" indicated by Figures 105 and 106 or the objectives for the area. **Note:** Ensure open snow interception stands have enough security cover* to be effective, and that some closed snow interception cover (≥70% crown closure) is available.
2. Identify locations of special habitats and note possible actions indicated on the diagram (in most cases simply protect them from disturbance and provide adjacent snow interception and security cover).
3. Decide whether further cover or forage areas are required on the lowland to approach the desired interspersion (use Figures 105 and 106 to determine size and distribution of areas). If so, carry out the forage treatments on preferred understory types (Table 15) wherever feasible.
4. Determine the best management scenario for the south-facing upland slopes, based on the availability of snow interception cover on the lowlands.
5. Concentrate management efforts on **upland south-facing slopes** that have an aspect of between 90 and 270° and slopes of 10-50%.
6. Decide on specific actions by referring to the pages noted in the diagram.



Special Habitats

ROCK OUTCROPS, WETLANDS, and RIPARIAN AREAS

Action: Treat adjacent areas to provide open snow interception cover and security cover* (except for rock outcrops in Scenario 1, where surrounding areas can be treated to provide security cover only, as described for spring range in the moderate snowpack zone [p. 160]). Use Figure 106 to determine appropriate widths for cover areas.

Table 15. Understory types with good winter forage potential for elk (see Appendix 1 for details)

LOWLAND	UPLAND
Deer fern	Huckleberry - Moss
Salmonberry - (Devil's club)	Salal - Dull Oregon-grape
Skunk cabbage	Salal - Huckleberry
Sword fern	

* **Security cover** that will hide 90% of a standing elk from view at a distance of 60 m or less **in the winter** (visual screening assessed after leaves have fallen) must also be available for the stands to be effective.

** The amount of cover required will depend on many factors, including the number of animals, the extent and composition of lowland habitats, the carrying capacity, and the management objectives. Consult the Ministry of Environment.

Techniques for elk winter range in the moderate snowpack zone

The main techniques for managing elk winter habitat are summarized below, but managers are encouraged to consult for details the landscape illustration on the two preceding pages and the "Techniques for Managing Forage and Cover" tables at the end of this chapter (pp. 190-195).

FORAGE TECHNIQUES

- Harvest narrow blocks (<400 m wide) on appropriate understory types.
- Control debris depth.
- To increase forage further, consider seeding cutblocks and roadsides with grasses and herbs.
- Once cutblocks are regenerated, limit herbicide application to spot treatments around crop trees.
- Thin to maintain <70% canopy closure if forage species are still abundant in the understory of the stand.
- Cut back and top shrubs and small western redcedar >2 m high to a height of <1 m. This encourages sprouting and increases available forage.

Figure 107. See the tables of techniques for managing forage and cover, pp. 190-195, to determine measures for successional stages.

SECURITY AND THERMAL COVER TECHNIQUES

To prepare for future cover areas:

- Keep harvested blocks narrow (100-500 m wide).
- Maintain, wherever possible, advanced coniferous regeneration (especially shade-tolerant species such as western redcedar and western hemlock).
- Control debris depth.
- Maintain soil conditions suitable for shade-tolerant species by avoiding hot broadcast burns and widespread scarification.
- Plant or regenerate naturally to >500 stems per hectare. Include, whenever possible, shade-tolerant species such as western redcedar and western hemlock as part of the species mix.
- Whenever possible, choose stands with a substantial component of western redcedar and western hemlock for thinning. These shade-tolerant species should ideally constitute ≥10% of the overstory after treatment.
- Maintain cover adjacent to special habitats.

SNOW INTERCEPTION COVER TECHNIQUES

To treat younger stands which still support abundant understory vegetation:

- Thin before canopy closure first reaches 70%, to produce 60-70% closure in areas of open snow interception cover and 70-90% in areas of closed snow interception cover after the trees reach 10 m high.
- When thinning, aim for a final crop tree density of 150-300 crop trees per hectare to maximize crown volume of individual trees, unless snow interception is adequate at higher densities.
- Retain conifer thickets, especially around openings, and leave 10-15% western hemlock and/or western redcedar in the overstory for seed production to establish future thickets.
- If there is little winter security cover available (conifers with live branches at ground level), do not prune trees along edges of openings.
- Maintain cover adjacent to special habitats.
- Consider fertilizing to promote rapid tree growth and understory productivity on nutrient-poor sites.

To treat Old Growth and older stands of Young/Mature Timber which have lost forage vegetation:

- Prepare for future snow interception cover by clear-cutting areas of 5-80 ha. Avoid burning, if possible, to retain shrubs and maintain organic soil substrate for western hemlock and western redcedar. If the sites have been burned, consider managing them initially as spring forage areas.
- Maintain, wherever possible, advanced coniferous regeneration (especially shade-tolerant species such as western redcedar and western hemlock).
- Maintain cover adjacent to special habitats.
- Where climatic and edaphic conditions allow, plant Douglas-fir and a small proportion (10-15%) of western redcedar and/or western hemlock.

Managing Deer and Elk Spring Range in the Moderate Snowpack Zone

What are the common habitat problems?

On many potential spring ranges, growth of forage species is limited by the closed canopies of dense young forests. To maintain productive deer and elk populations, spring range providing abundant nutritious forage is important. Good winter habitat cannot make up for a lack of spring and summer forage.

In other areas, extensive mature and old-growth stands provide spring forage of low to moderate value. These areas can also benefit from increased forage production, especially near winter ranges.

What is required?

Both deer and elk benefit from abundant herbs and shrubs during early spring. To create forage:

1. sequentially harvest and burn a series of cutblocks around winter ranges to ensure that a continuous supply of forage (especially fireweed and other herbs) is produced in clearcuts and early successional stages (Figure 108a); or
2. heavily thin one or more stands, thin more lightly but repeatedly (Figure 108b), or maintain existing openings within the stands. Thinning to increase forage is recommended only in stands that presently support at least some preferred forage species. Also, when thinning to promote spring forage, remember that the resulting low-density stands may be suitable for management as winter range in future years.

Where and how can stands be managed?

To obtain the greatest benefit, log or thin on sites with optimum topography (see sidebar and Figure 71, p. 101) and with understory types having high potential for forage production (see p. 161). However, management of other topographic positions and other understory types is still beneficial as long as adequate security and thermal cover are available adjacent to forage treatment areas. Finally, special habitats (especially riparian areas and wetlands for elk) should be protected.

The next four pages are designed to help you decide where and how to manage spring habitat. An example on the opposite page depicts one possible approach for managing spring habitat, suggests a sequence for determining treatments, and shows where relevant information can be found. A two-page graphic follows, illustrating the desired distribution and type of forage and cover areas. Finally, techniques suitable for managing spring habitat are explained on page 162.

Spring Range Parameters

Slope: ≥40%
Aspect: 90-270°
Special considerations: located <2 km from winter range (deer only)

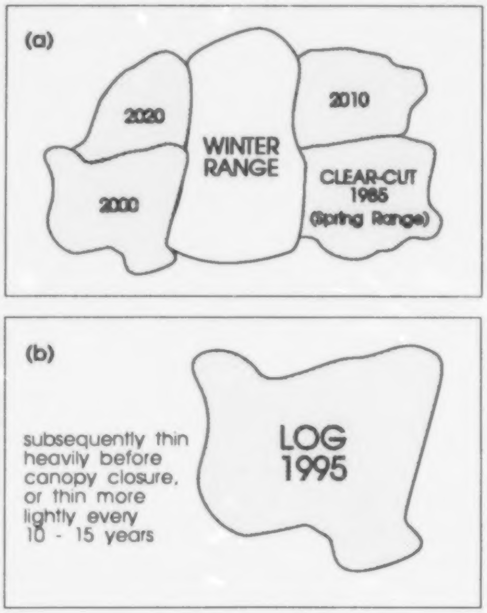
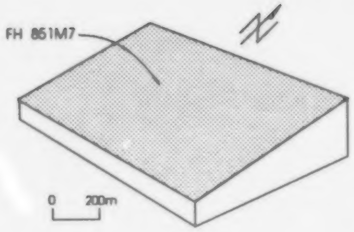

(a)
2020
2010
WINTER RANGE
2000
CLEAR-CUT 1985 (Spring Range)
(b)
subsequently thin heavily before canopy closure, or thin more lightly every 10 - 15 years
LOG 1995

Figure 108. Spring forage may be maintained by sequential harvests (a), by a single heavy thinning, or by repeated lighter thinnings (b).

An Example of Spring Range Habitat Creation

Objective: To provide abundant spring forage for deer adjacent to critical winter range



FIRST: ***Identify habitat problems and opportunities (using the following two pages).***

Forest type:

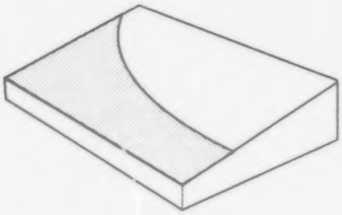
- Uniform mature stand of Douglas-fir and western hemlock (FH 851M7*)

Successional stage:

○ Old Growth with variable (60-90%) crown closure

Habitat problem:

The old growth provides excellent winter range and adequate security and thermal cover during the spring, but very limited spring forage.



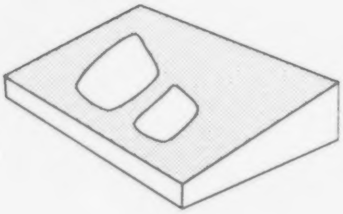
SECOND: ***Map understory types and special habitats (using the next two pages and Appendix 1 [p. 239]).***

Understory types:

○ Moss understory type (low forage potential for both deer and elk)
○ Sword fern understory type (high forage potential for both species)

Special habitats:

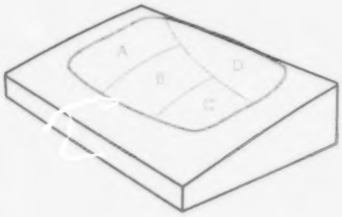
- None



THIRD: ***Determine desired forage and cover pattern (using the following two pages).***

Given the large area of Sword fern understory type, which has high potential for forage production, a block of timber could be clear-cut to increase forage. Later, forage could be maintained in portions of the clearcut using an extended thinning program. Good security and thermal cover will be provided in the old-growth winter range surrounding the forage area.

○ Forage area scheduled for continuous forage production
○ Security and thermal cover area



FOURTH: ***Determine treatments (using the next two pages and the tables starting on p. 190).***

Habitat management strategy:

Harvest a cutblock which is predominantly on the better understory type for forage production. Then, within 15 years, thin some portions of the cutblock to maintain forage species.

Treatments:

Year 1 - Harvest cutblock to obtain:
- good forage availability in areas "A", "B", and "C" (on the understory type with high forage potential);
- fair forage availability in area "D" (on the understory type with lower forage potential).

Year 13 - Thin areas "A" and "C" to 600 stems/ha or less to maintain forage (see "Techniques for Managing Forage" table, p. 190). (Note: Areas "B" and "D" will provide security cover; old-growth will provide thermal cover.)

Year 20 - Continue to thin areas "A" and "C" to maintain forage.

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[*] The codes for forest cover types are explained in Appendix 5 (p. 293).

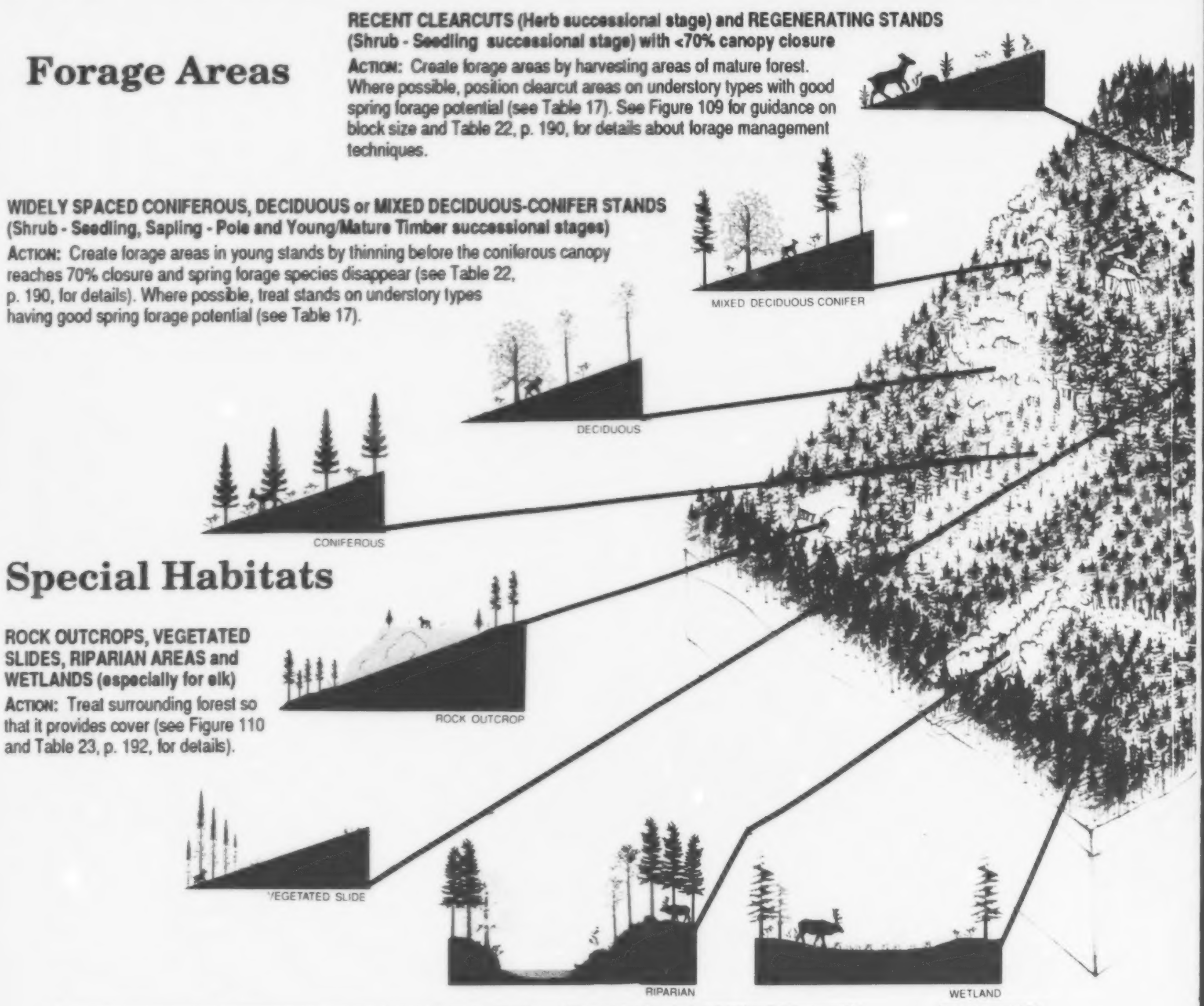
Distribution of Forage and Cover for Deer and Elk on Spring Ranges

Optimally, forage areas no more than 400 m wide would be interspersed with cover areas 100-500 m wide (see Figures 109 and 110 below).

Manage spring range areas to provide a patchwork of stands with open and closed canopies.

Good **forage** is produced in:

- recent clearcuts,
- open forests (crown closure <70%), with understory types providing preferred forage species (see Table 17), and



Forage Areas

RECENT CLEARCUTS (Herb successional stage) and REGENERATING STANDS (Shrub - Seedling successional stage) with <70% canopy closure

Action: Create forage areas by harvesting areas of mature forest. Where possible, position clearcut areas on understory types with good spring forage potential (see Table 17). See Figure 109 for guidance on block size and Table 22, p. 190, for details about forage management techniques.

WIDELY SPACED CONIFEROUS, DECIDUOUS or MIXED DECIDUOUS-CONIFER STANDS (Shrub - Seedling, Sapling - Pole and Young/Mature Timber successional stages)

Action: Create forage areas in young stands by thinning before the coniferous canopy reaches 70% closure and spring forage species disappear (see Table 22, p. 190, for details). Where possible, treat stands on understory types having good spring forage potential (see Table 17).

Special Habitats

ROCK OUTCROPS, VEGETATED SLIDES, RIPARIAN AREAS and WETLANDS (especially for elk)

Action: Treat surrounding forest so that it provides cover (see Figure 110 and Table 23, p. 192, for details).

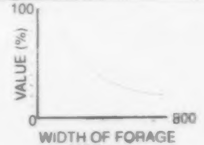


*Figure 109. Open **forage** areas decrease in value to deer and elk as width increases above 120 m.*

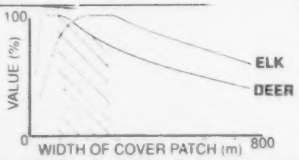


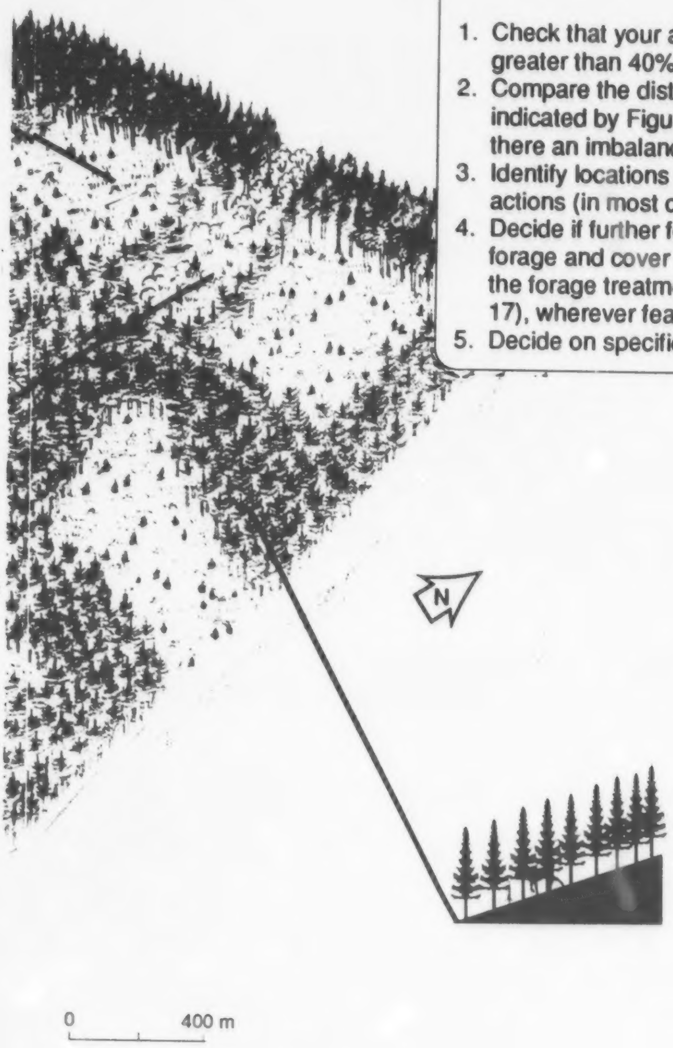
*Figure 110. Optimal width of **cover** areas ranges from 100 to 500 m.*

- the special habitats shown in the diagram.

Security cover is provided by most fully stocked forests ≥2 m high (deer) or ≥3 m high (elk). These stands also provide **thermal cover** suitable for most weather conditions. Stands ≥10 m high and with ≥70% crown closure should account for >10% of the cover area to provide thermal cover for the most adverse conditions.

How to Use this Information

1. Check that your area has a southerly aspect (between 90 and 270°), a slope greater than 40%, and, for deer, proximity to winter range (see Table 16 below).
2. Compare the distribution of forage and cover areas on your area to the "ideal" indicated by Figures 109 and 110 or the objectives for the management area. Is there an imbalance?
3. Identify locations of special habitats and note from the diagram the possible actions (in most cases, simply protect them and provide adjacent cover).
4. Decide if further forage or cover areas are required to improve interspersion of forage and cover areas (use Figures 109 and 110 for guidance). If so, carry out the forage treatments on understory types having good forage potential (Table 17), wherever feasible.
5. Decide on specific actions by referring to the pages noted in the diagram.



Cover Areas

DENSE CONIFEROUS STANDS

Deer: (All successional stages except Herb) ≥2 m high.
Elk: (All successional stages except Herb and Shrub - Seedling) ≥3 m high.
Both: Some scattered stands, making up ≥10% of the cover area, ≥10 m high with canopies ≥70% closed for thermal cover.

ACTION: Treat so that vegetation is kept dense enough to hide 90% of a deer or elk at ≤60 m (on average) throughout the stand. In addition, maintain interspersed thermal cover. See Table 23, p. 192.

Table 16. Optimum distance between winter and spring ranges for deer

Immediately adjacent	Excellent
< 400 m	Good
400 m - 2.0 km	Fair
> 2.0 km	Poor

Table 17. Understory types with good spring forage potential for deer and elk (see Appendix 1 for details)

DEER	ELK
Deer fern	Deer fern
Huckleberry - Moss	Huckleberry - Moss
Huckleberry - Rosy twistedstalk	Huckleberry - Rosy twistedstalk
Moss - Dull Oregon-grape	Salmonberry - (Devil's club)
Oak fern	Skunk cabbage
Salal - Dull Oregon-grape	Sword fern
Salal - Huckleberry	
Salmonberry - (Devil's club)	
Skunk cabbage	
Sword fern	

Techniques for deer and elk spring range in the moderate snowpack zone

The techniques most commonly used on spring ranges focus on providing a mix of forage and security cover in close proximity. The main techniques are summarized below, but managers are encouraged to consult for details the landscape illustration on the two preceding pages and the "Techniques for Managing Forage and Cover" tables at the end of this chapter (pp. 190-193).

FORAGE TECHNIQUES

- Clear-cut narrow blocks (<400 m wide) on appropriate understory types.
- Encourage herbs where soil conditions allow by:
    1. burning to reduce dense shrubs where they persist after logging, or
    2. scarifying to expose mineral soil.
- Control debris depth.
- To increase forage further, consider seeding cutblocks and roadsides with grasses and herbs.
- Once cutblocks are regenerated, limit herbicide application to spot treatments around crop trees.
- Thin to maintain <70% canopy closure if forage species are still abundant in the understory of the stand.
- Cut back and top shrubs and small western redcedar >2 m high to a height of <1 m. This encourages sprouting and increases available forage.

SECURITY AND THERMAL COVER TECHNIQUES

To prepare for future cover areas:

- Keep harvested blocks narrow (100-500 m wide).
- Maintain, wherever possible, advanced coniferous regeneration (especially shade-tolerant species such as western redcedar and western hemlock).
- Control debris depth.
- Maintain soil conditions suitable for shade-tolerant species by avoiding hot broadcast burns and widespread scarification.
- Plant or regenerate naturally to >500 stems per hectare. Include, whenever possible, shade-tolerant species such as western redcedar and western hemlock as part of the species mix.
- Whenever possible, choose stands with a substantial component of western redcedar and western hemlock for thinning. These shade-tolerant species should ideally constitute ≥10% of the overstory after treatment.
- Maintain cover adjacent to special habitats.

Figure 111. See the "Techniques for Managing Forage" table, p. 190, and the "Techniques for Managing Security and Thermal Cover" table, p. 192, to determine measures for successional stages.

Notes

Managing Deer and Elk Summer Range in the Moderate Snowpack Zone

What are the common habitat problems?

On many potential summer ranges in the moderate snowpack zone, dense young forests with closed canopies provide good security and thermal cover but grow little forage (Figure 112). Thus, the main habitat problem on summer ranges in this zone is an imbalance between forage and cover areas.

What is required?

To address the imbalance between forage and cover, create forage areas by either:

1. sequentially harvesting and burning a series of cutblocks to ensure that a continuous supply of forage (especially fireweed, other herbs, and shrubs) is produced in clearcuts and early successional stages (Figure 113); or
2. heavily thinning one or more stands, thinning more lightly but repeatedly, or maintaining specific openings within the stands. Note that such management will only be worthwhile in stands that now support at least some preferred forage species.

Where and how can stands be managed?

To obtain the greatest benefit, log or thin on sites with understory types having high potential for forage production (see p. 167) and protect special habitats (especially riparian areas and wetlands for elk). However, management of virtually any understory type and topographic position to enhance forage is beneficial as long as adequate security and thermal cover are available adjacent to forage areas.

Industrial activities on elk calving areas should be scheduled either before May 15 or after July 15 so that cows and calves are not disturbed.

The next four pages are designed to help you decide where and how to manage summer habitat. An example on the opposite page depicts one possible approach for managing summer habitat, suggests a sequence for determining treatments, and shows where relevant information can be found. A two-page graphic follows, illustrating the desired distribution and type of forage and cover areas. Finally, techniques suitable for managing summer habitat are explained on page 168.

Summer Range Parameters

Slope: all slopes
Aspect: all aspects
Special considerations: none

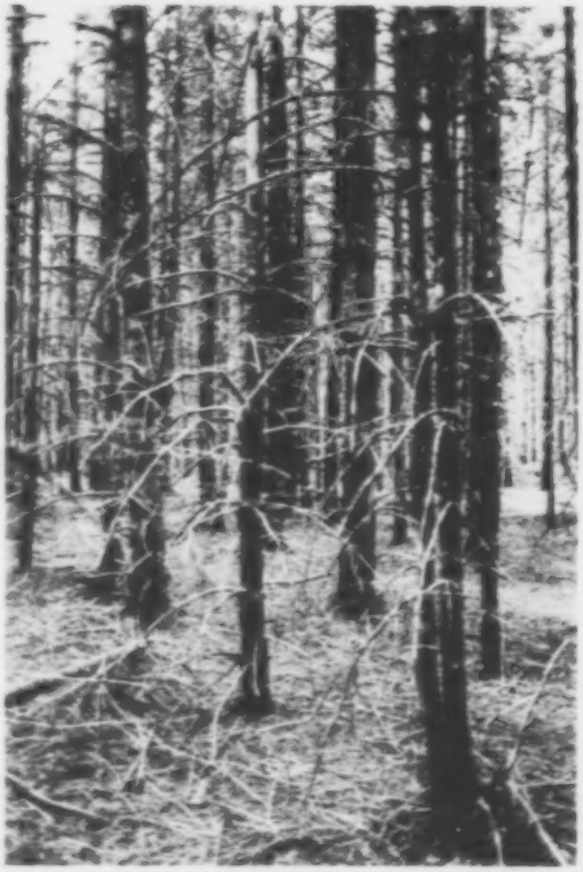


Figure 112. Extensive dense forests restrict forage production.

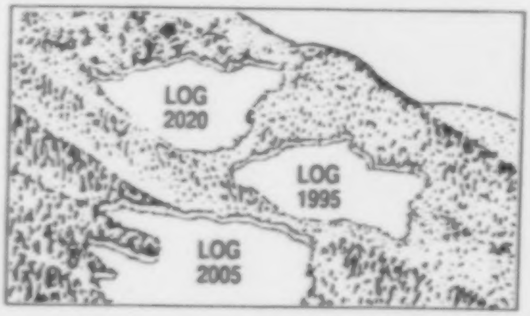
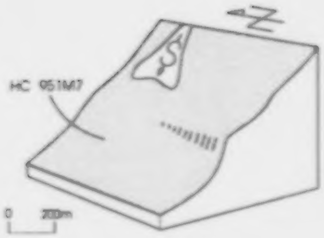


Figure 113. Sequential logging to provide forage can enhance summer ranges.

An Example of Summer Range Habitat Management

Objective: To provide a balance of summer forage and cover for deer and elk



FIRST: ***Identify habitat problems and opportunities (using the following two pages).***

Forest type:

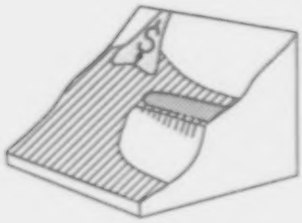
- Old-growth western hemlock and redcedar (HC 951M7*)

Successional stage:

○ Old Growth with variable (60-90%) crown closure

Habitat problem:

Although adequate security and thermal cover are present, little high-quality summer forage is available.



SECOND: ***Map understory types, special habitats, and known elk calving areas (using the next two pages and Appendix 1 [p. 239]).***

Understory types:

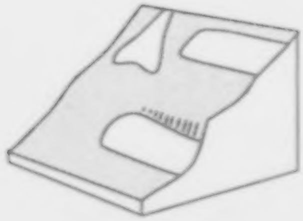
○ Huckleberry - Moss understory type (higher summer forage potential for both deer and elk)

⊘ Rosy twistedstalk - Five-leaved bramble understory type (lower summer forage potential for both deer and elk)

Special habitats and elk calving area:

○ Vegetated slide

● Known calving location

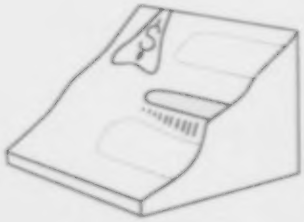


THIRD: ***Determine desired forage and cover pattern (using the following two pages).***

Forage areas could be created on the understory type with higher forage potential (Huckleberry - Moss). Cover areas could be located adjacent to the slide, on the elk calving area, and on the understory type with lower forage potential (Rosy twistedstalk - Five-leaved bramble).

○ Forage area

○ Security and thermal cover area



FOURTH: ***Determine treatments (using the next two pages and the "Techniques for Managing Forage" table on p. 190).***

Habitat management strategy:

Harvest cutblocks on the understory type with the best forage production potential. Because future cutblocks planned nearby will provide forage later, no further treatments will be conducted in the area depicted in the illustration.

Treatments:

Year 1 - Harvest two cutblocks on the Huckleberry - Moss understory type to increase forage availability. These blocks, above and below the elk calving area, should be treated after July 15 to minimize disturbance during calving. Retain cover adjacent to the vegetated slide.

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* The codes for forest cover types are explained in Appendix 5 (p. 283).

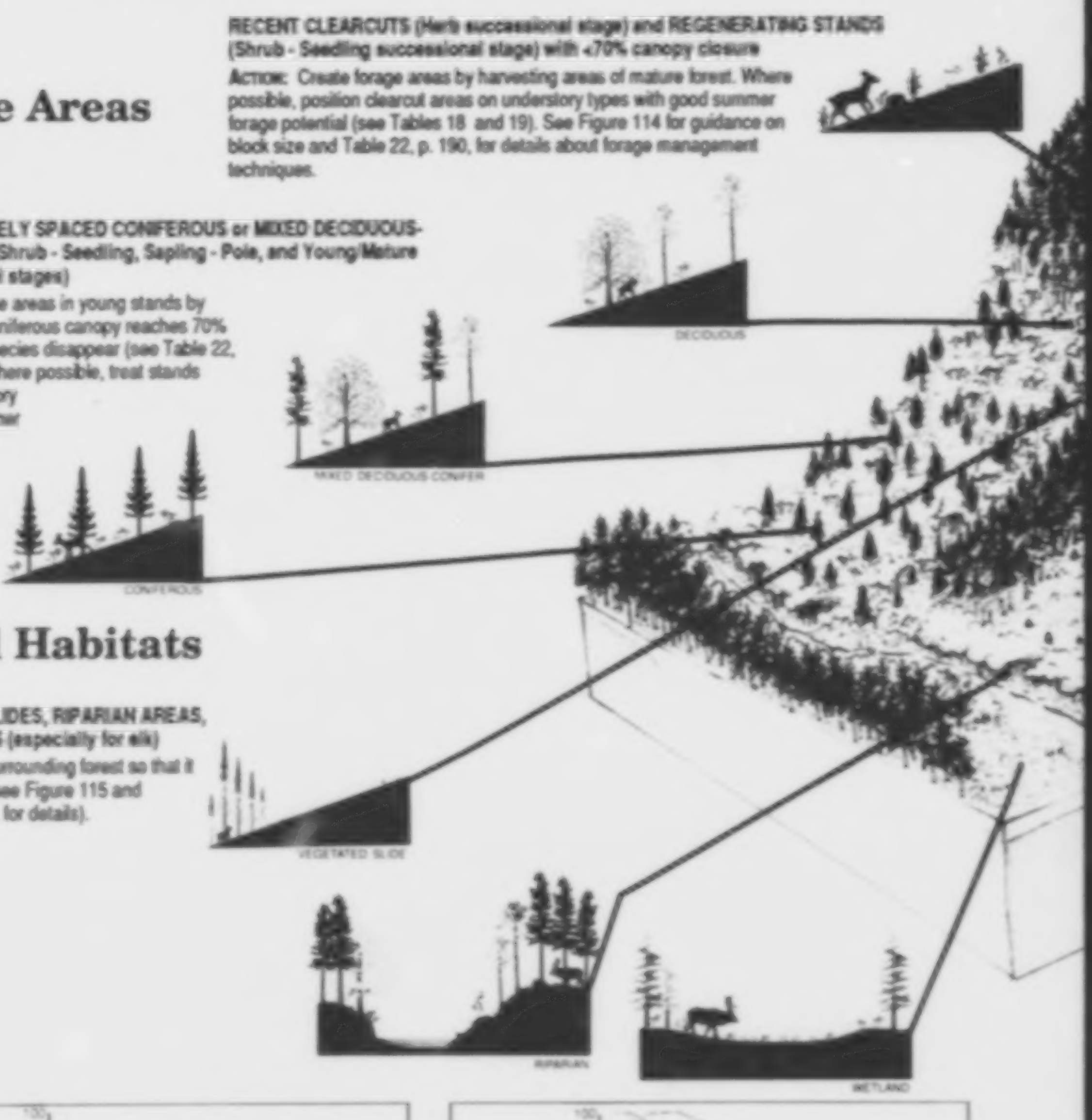
Distribution of Forage and Cover for Deer and Elk on Summer Ranges

Optimally, forage areas no more than 400 m wide would be interspersed with cover areas 100-500 m wide (see Figures 114 and 115 below).

Manage summer range areas to provide a patchwork of stands with open and closed canopies.

Good **forage** is produced in:

- recent clearcuts,
- open forests (crown closure <70%), with understory types providing preferred forage species (see Tables 18 and 19), and



Forage Areas

RECENT CLEARCUTS (Herb successional stage) and REGENERATING STANDS (Shrub - Seedling successional stage) with <70% canopy closure

Action: Create forage areas by harvesting areas of mature forest. Where possible, position clearcut areas on understory types with good summer forage potential (see Tables 18 and 19). See Figure 114 for guidance on block size and Table 22, p. 190, for details about forage management techniques.

DECIDUOUS or WIDELY SPACED CONIFEROUS or MIXED DECIDUOUS-CONIFER STANDS (Shrub - Seedling, Sapling - Pole, and Young/Mature Timber successional stages)

Action: Create forage areas in young stands by thinning before the coniferous canopy reaches 70% closure and forage species disappear (see Table 22, p. 190, for details). Where possible, treat stands which are on understory types with good summer forage potential (see Tables 18 and 19).

Special Habitats

VEGETATED SLIDES, RIPARIAN AREAS, and WETLANDS (especially for elk)

Action: Treat surrounding forest so that it provides cover (see Figure 115 and Table 23, p. 192, for details).

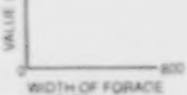


Figure 114. Open forage areas decrease in value to deer and elk as width increases above 120 m.

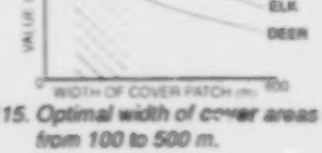


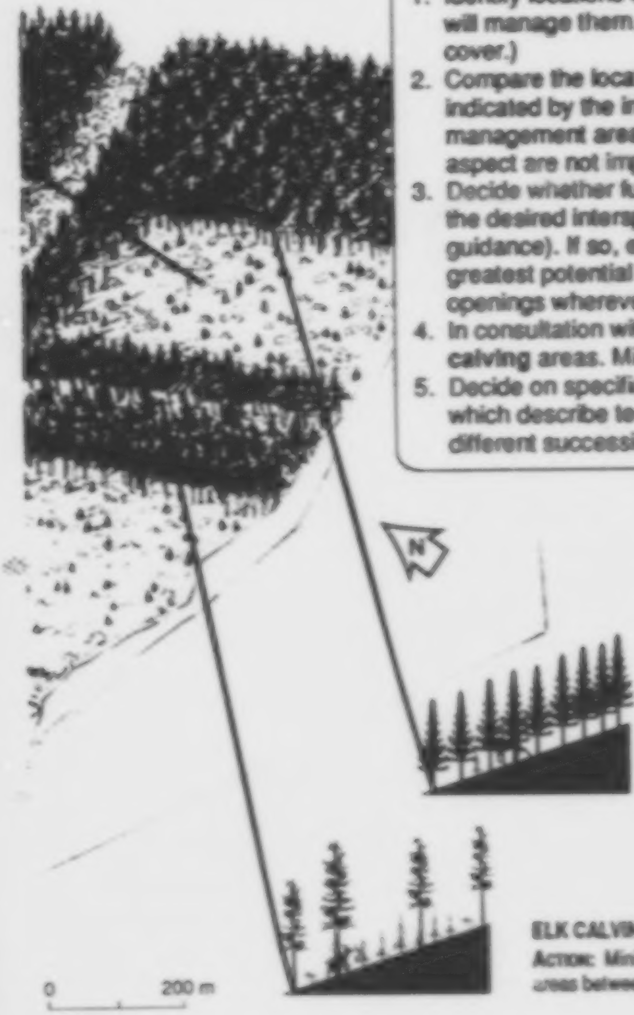
Figure 115. Optimal width of cover areas ranges from 100 to 500 m.

- the special habitats shown in the diagram.

Security cover is provided by most fully stocked forests ≥2 m high (deer) or ≥3 m high (elk). These stands also provide **thermal cover** suitable for most weather conditions. Stands ≥10 m high and with ≥70% crown closure should make up >10% of the cover area to provide thermal cover for the most adverse conditions.

How to Use this Information

1. Identify locations of any special habitats in your area and determine how you will manage them. (In most cases, simply protect them and provide adjacent cover.)
2. Compare the location and pattern of forage and cover in your area to the "ideal" indicated by the information on these two pages or the objectives for the management area. Note that, unlike winter and spring ranges, slope and aspect are not important. Are significant improvements possible?
3. Decide whether further forage or cover areas are required to bring your area to the desired interspersion of forage and cover (use Figures 114 and 115 for guidance). If so, establish forage treatments on understory types with the greatest potential to produce summer forage and take advantage of natural openings wherever feasible.
4. In consultation with the Ministry of Environment, identify the location of **elk calving areas**. Minimize activity in these areas between 15 May and 15 July.
5. Decide on specific actions by referring to the tables at the end of the chapter, which describe techniques for managing forage and cover and outline how different successional stages can be treated.



Cover Areas

DENSE CONIFEROUS STANDS

Deer: (All successional stages except Herb) ≥2 m high.
Elk: (All successional stages except Herb and Shrub - Seedling) ≥3 m high.
Both: Some scattered stands, making up ≥10% of the cover area, ≥10 m high with canopies ≥70% closed for thermal cover.

ACTION: Treat so that vegetation is kept dense enough to hide 90% of a deer or elk at ≤60 m (on average) throughout the stand. In addition, maintain interspersed thermal cover. See Table 23, p. 192.

ELK CALVING AREAS

ACTION: Minimize activity on known calving areas between 15 May and 15 July.

Table 18. Understory types with good summer forage potential for deer (see Appendix 1 for details)

Deer fern
Huckleberry - Moss
Huckleberry - Rosy twistedstalk
Moss - Dull Oregon-grape
Oak fern
Ocean-spray - Tall Oregon-grape
Salal - Dull Oregon-grape
Salal - Huckleberry
Salmonberry - (Devil's club)
Skunk cabbage
Sword fern

Table 19. Understory types with good summer forage potential for elk (see Appendix 1 for details)

Deer fern
Huckleberry - Moss
Huckleberry - Rosy twistedstalk
Salmonberry - (Devil's club)
Skunk cabbage
Sword fern

Techniques for deer and elk summer range in the moderate snowpack zone

The techniques most commonly used on summer ranges are identical to those used on spring ranges and usually focus on treating old growth and sapling - pole stands to produce and maintain forage. The main techniques are summarized below, but managers are encouraged to consult for details the landscape illustration on the two preceding pages and the "Techniques for Managing Forage and Cover" tables at the end of this chapter (pp. 190-193).

FORAGE TECHNIQUES

- Clear-cut narrow blocks (<400 m wide) on appropriate understory types.
- Control debris depth.
- Encourage herbs where soil conditions allow by:
  1. burning to reduce dense shrubs where they persist after logging, or
  2. scarifying to expose mineral soil.
- If forage is in particularly short supply, consider:
  1. seeding cutblocks and roadsides with grasses and herbs, and
  2. once cutblocks are regenerated, limiting herbicide application to spot treatments around crop trees.
- Thin to maintain <70% canopy closure if forage species are still abundant in the understory of the stand.
- Cut back and top shrubs and western redcedar >2 m high to a height of <1 m. This encourages sprouting and increases available forage.

SECURITY AND THERMAL COVER TECHNIQUES

To prepare for future cover areas:

- Keep harvested blocks narrow (100-500 m wide).
- Maintain, wherever possible, advanced coniferous regeneration (especially shade-tolerant species such as western redcedar and western hemlock).
- Control debris depth.
- Maintain soil conditions suitable for shade-tolerant species by avoiding hot broadcast burns and widespread scarification.
- Plant or regenerate naturally to >500 stems per hectare. Include, whenever possible, shade-tolerant species such as western redcedar and western hemlock as part of the species mix.
- Whenever possible, choose stands with a substantial component of western redcedar and western hemlock for thinning. These shade-tolerant species should ideally constitute ≥10% of the overstory after treatment.
- Maintain cover adjacent to special habitats.

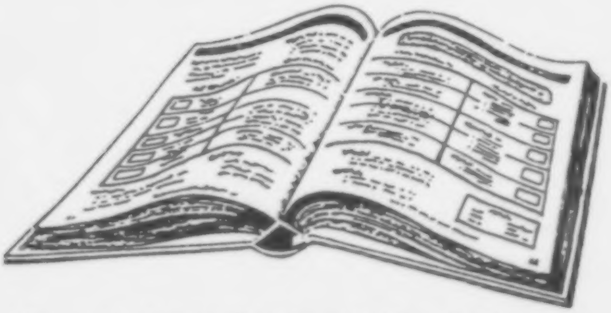


Figure 116. See the "Techniques for Managing Forage" table, p. 190, and the "Techniques for Managing Security and Thermal Cover" table, p. 192, to determine measures for successional stages.

Notes

Summary of the Moderate Snowpack Zone

Deer: winter

SEASONAL RANGE LOCATIONS

- Deer winter range is usually on southerly aspects with steep slopes (≥40%) exposed to winter sun.

COMMON HABITAT PROBLEMS

- Many critical winter ranges lack good habitat because clearcut areas and dense young forests regenerated after logging do not provide adequate forage and cover. Also, many potential critical winter ranges have no spring ranges nearby.

HABITAT MANAGEMENT EMPHASIS

- Maintain existing old-growth forests on sites with suitable topography or experiment with winter habitat creation in young growth, or do both.

COMMON HABITAT MANAGEMENT TECHNIQUES

- Techniques usually focus on thinning Sapling - Pole successional stages to produce and maintain forage and cover within the same stand.

CAUTIONS

- Incorporate rock outcrops and other natural openings, whenever possible, in treatment areas.
- Monitor effectiveness of treated areas and postpone harvesting adjacent areas until deer use the managed winter habitat during severe winter conditions.

Elk: winter

SEASONAL RANGE LOCATIONS

- Elk winter range is located on two distinct topographic types: lowland gentle slopes (with slopes between 0 and 10%) and adjacent upland south-facing slopes (usually on southerly aspects with slopes of 10-50% exposed to winter sun).

COMMON HABITAT PROBLEMS

- As with critical winter ranges for deer, many elk winter ranges lack good habitat because dense young forests regenerated after logging do not provide adequate forage and cover in close proximity.

HABITAT MANAGEMENT EMPHASIS

- Maintain existing old-growth forests when managing snow interception cover on the lowlands (and upland south-facing slopes when applicable) or create snow interception cover in young growth, or do both.

COMMON HABITAT MANAGEMENT TECHNIQUES

- Techniques usually focus on creating an interspersion of forage and cover areas through space and time, often by a combination of clear-cutting small blocks and thinning.

CAUTIONS

- Protect special habitats (rock outcrops, riparian areas, wetlands) from disturbance with adjacent snow interception or security cover. Visual screens may be required to buffer special habitats from human activity, such as main haul roads.
- Monitor effectiveness of treated areas and postpone harvesting adjacent areas until elk use the managed winter habitat during severe winter conditions.

Deer and elk: spring

SEASONAL RANGE LOCATIONS

- Spring range for both deer and elk is usually on southerly aspects with steep slopes (≥40%). In addition, elk regularly use riparian areas and wetland special habitats during the spring.

COMMON HABITAT PROBLEMS

- On many potential spring ranges, growth of forage species is limited by the closed canopies of dense young forests.

HABITAT MANAGEMENT EMPHASIS

- Create forage areas close to winter ranges to provide abundant, nutritious forage in the early spring.

COMMON HABITAT MANAGEMENT TECHNIQUES

- Techniques usually focus on creating forage beside cover areas by either sequentially harvesting and burning small cutblocks or thinning stands which still have abundant spring forage species in the understory.

CAUTIONS

- Check that adequate security and thermal cover are present next to planned forage areas.
- Protect special habitats (especially riparian areas and wetlands for elk) from disturbance by siting roads and harvesting activities well back and maintaining a visual screen.

Deer and elk: summer

SEASONAL RANGE LOCATIONS

- Summer range for both deer and elk is found on all aspects and slopes.

COMMON HABITAT PROBLEMS

- Many potential summer ranges have old growth or young dense forests with closed canopies that provide little forage.
- Disturbance of elk cows and their new-born calves is a concern in some areas.

HABITAT MANAGEMENT EMPHASIS

- Focus efforts on producing forage on appropriate understory types with cover nearby, and on protecting special habitats during forestry activities.

COMMON HABITAT MANAGEMENT TECHNIQUES

- Forage can usually be provided as a by-product of planned logging operations. However, in areas where logging is not anticipated in the near future, thinning of stands having an understory of preferred forage species can also provide summer forage.

CAUTIONS

- Check that adequate security and thermal cover are present next to planned forage areas.
- When possible, before deciding where to locate treatment areas, identify elk calving areas and protect them from disturbance (between May 15 and July 15).
- Protect special habitats, especially wetlands and vegetated slides, from disturbance by siting roads and harvesting activities well back and maintaining a visual screen.

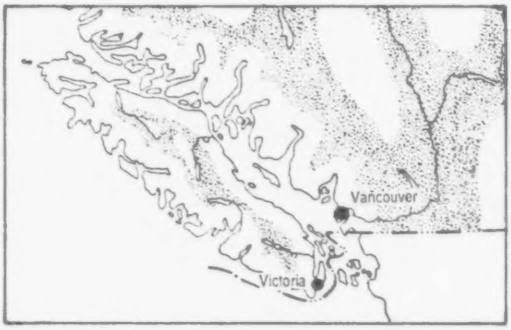
APPLYING TECHNIQUES IN THE DEEP SNOWPACK ZONE

The deep snowpack zone usually lies between 500 and 900 m elevation in mountainous areas of Vancouver Island and the mainland (Figures 14 and 117). As in the moderate snowpack zone, snow depths significantly affect deer and elk distribution. Most animals are migratory. Many migratory elk summer in this zone and move to winter ranges in the moderate and shallow zones.

Deer and elk capability is lower than in the moderate and shallow snowpack zones because of more severe winters. Loss of winter ranges to logging and the need to maintain long-term supply of spring range are the major concerns of habitat managers. South-facing slopes are important as spring range for both deer and elk, and as winter range for deer. Southerly slopes are also important for elk winter range if little old growth is available on lowland gentle slopes.

The problem of inadequate snow interception cover as a result of reduction of old-growth stands is common in this zone. Because old growth is crucial to deer and elk survival in deep snow, old-growth retention is the preferred means of maintaining critical winter habitat. However, experimentation with winter range creation in young stands is suggested for a few selected areas when some old growth must be harvested on winter ranges. On spring and summer ranges habitat manipulation is readily feasible, especially when additional forage is needed.

Since management in this snowpack zone is similar to that in the moderate zone, the following pages make frequent reference to that zone. For each seasonal range, minor differences between the two zones in common habitat problems and opportunities, forage and cover patterns, and techniques are briefly described.



Deep Snowpack Zone Characteristics

Elevation: usually between 500 and 900 m

Maximum snow depths: often >60 cm; lasting 2 weeks or more

Frequency of critical snowpacks (depth of snow ≥45 cm for ≥30 days): one per 3-10 years

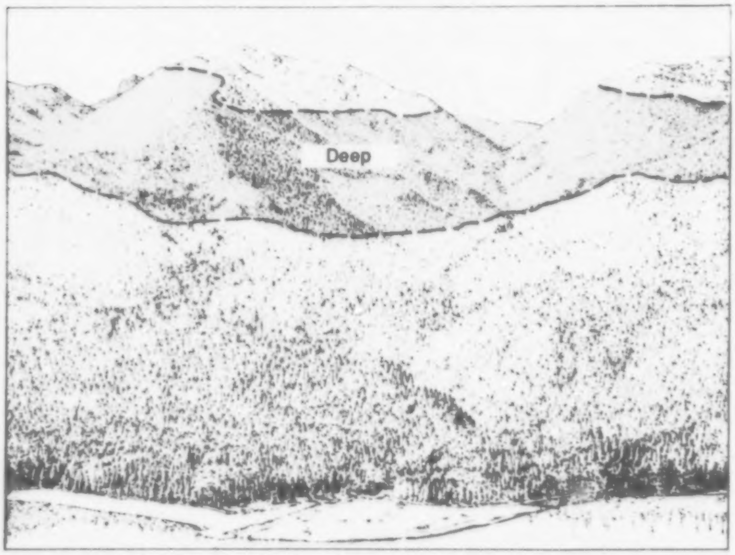


Figure 117. A schematic diagram of the location of the deep snowpack zone.

Managing Deer and Elk Winter Range in the Deep Snowpack Zone

What are the common habitat problems?

Winter habitat problems in this zone are virtually identical to those found in the moderate snowpack zone. Many potential winter ranges for deer and elk lack good habitat because past logging activity has removed most old-growth forests, leaving clearcuts and dense young stands which do not provide adequate forage and cover. The only difference is that, because of the deeper snowpack in this zone, the problems are more severe. In addition, many potential winter ranges do not have spring ranges nearby. For further details, see "Managing Deer Winter Range in the Moderate Snowpack Zone" (pp. 143-149) and "Managing Elk Winter Range in the Moderate Snowpack Zone" (pp. 150-157).

What is required?

The habitat required by both deer and elk to survive the harsh winter months in this zone is nearly identical to that in the moderate snowpack zone winter ranges. However, only old-growth timber can be expected to provide deer with critical winter range (Figure 118); young-growth stands may not be adequate regardless of how they are managed, especially if lichen cannot be established. For elk, old-growth stands will provide optimal winter range, but managed younger stands may also be suitable to provide snow interception cover.

Where and how can stands be managed?

For deer, old-growth forests on sites with good topography (see sidebar) should be protected. Where all old growth has been removed, experimentation with creation of critical winter range for deer in young growth would be desirable.

For elk, winter ranges should be managed similarly to those in the moderate snowpack zone (see pp. 154-155) with emphasis placed on using old growth as snow interception cover. When selecting forage areas for elk, the Huckleberry - Dull Oregon-grape understory type can be used in addition to those areas noted for the moderate snowpack zone.

Deer Winter Range Parameters

Slope: ≥40%
Aspect: 110-250°
Special considerations: receives winter sun; spring range <2 km away

Elk Winter Range Parameters

Lowland Gentle Slopes

Aspect: all aspects, often on floodplains
Special considerations: none

Upland South-facing Slopes

Slope: 10-50%
Aspect: 90-270°
Special considerations: receives winter sun

Figure 118. Old-growth forests provide the best snow interception cover in the deep snowpack zone.

Managing Deer and Elk Spring Range in the Deep Snowpack Zone

What are the common habitat problems?

As with the potential spring ranges in the moderate snowpack zone, growth of forage species is limited by the closed canopies of dense young and old-growth forests. To maintain productive deer and elk populations, spring range providing abundant nutritious forage is important. Good winter habitat cannot make up for a lack of spring and summer forage.

What is required?

Both deer and elk benefit from abundant herbs and shrubs during early spring. Such forage may be created by:

1. sequentially harvesting and burning a series of cutblocks around winter ranges to ensure that a continuous supply of forage (especially fireweed and other herbs) is produced in clearcuts and early successional stages (Figure 119a); or
2. heavily thinning one or more stands, thinning more lightly but repeatedly (Figure 119b), or maintaining specific openings within the stands. Note that such management will only be worthwhile in stands that presently support at least some preferred forage species. Also, when thinning to promote spring forage, remember that the resulting low-density stands may be suitable for management as winter range in future years.

Where and how can stands be managed?

The greatest benefit will be obtained by logging or thinning on sites with optimum and moderate value topography (see sidebar and Figure 71, p. 101), with understory types having high potential for forage production. These include all the understory types listed for the moderate snowpack zone spring range (p. 161), plus Huckleberry - Dull Oregon-grape (deer) and Rosy twistedstalk - Five-leaved bramble (deer and elk). However, management of other topographic positions and other understory types is still beneficial as long as adequate security and thermal cover are available adjacent to forage treatment areas. Finally, special habitats (especially riparian areas and wetlands for elk) should be protected.

Since spring range in this zone can be managed like spring range in the moderate snowpack zone, refer to the example of habitat management (p. 159), the illustration of the desired distribution of forage and cover (pp. 160-161), and the techniques used (p. 162) in the moderate snowpack zone.

Spring Range Parameters

Slope: ≥40%

Aspect: 90-270°

Special considerations: located <2 km from winter range (deer only)

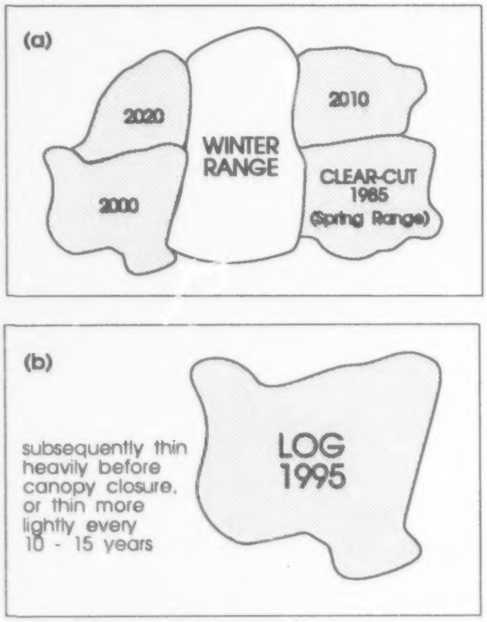

(a)
2020
2010
WINTER RANGE
2000
CLEAR-CUT 1985 (Spring Range)
(b)
subsequently thin heavily before canopy closure, or thin more lightly every 10 - 15 years
LOG 1995

Figure 119. Spring forage may be maintained by sequential harvests (a), by a single heavy thinning, or by repeated lighter thinnings (b).

Managing Deer and Elk Summer Range in the Deep Snowpack Zone

What are the common habitat problems?

As in the moderate snowpack zone, many potential summer ranges are covered in dense forests that provide good security and thermal cover but grow little forage (Figure 120). Thus, the main habitat problem on summer ranges in this zone is an imbalance between forage and cover areas.

What is required?

To address the imbalance between forage and cover, create forage areas by either:

1. sequentially harvesting and burning a series of cutblocks to ensure that a continuous supply of forage (especially fireweed, other herbs, and shrubs) is produced in clearcuts and early successional stages (Figure 121); or
2. heavily thinning one or more stands, thinning more lightly but repeatedly, or maintaining specific openings within the stands. Note that such management will only be worthwhile in stands that presently support at least some preferred forage.

Where and how can stands be managed?

To obtain the greatest benefit, log or thin on sites with understory types having high potential for forage production (these include all the understory types listed for the moderate snowpack zone summer range [p. 167], plus Huckleberry - Dull Oregon-grape [deer] and Rosy twistedstalk - Five-leaved bramble [deer and elk]); and by protecting special habitats (especially vegetated slides and wetlands for elk). However, management of virtually all understory types and topographic positions to enhance forage is beneficial as long as adequate security and thermal cover are available adjacent to forage areas.

Industrial activities on elk calving areas should be scheduled either before May 15 or after July 15 so cows and calves are not disturbed.

Since summer range in this zone can be managed like summer range in the moderate snowpack zone, refer to the example of habitat management (p. 165), the illustration of the desired distribution of forage and cover (pp. 166-167), and the techniques used (p. 168) in the moderate snowpack zone.

Summer Range Parameters

Slope: all slopes
Aspect: all aspects
Special considerations: none

Figure 120. Extensive dense forests restrict forage production.

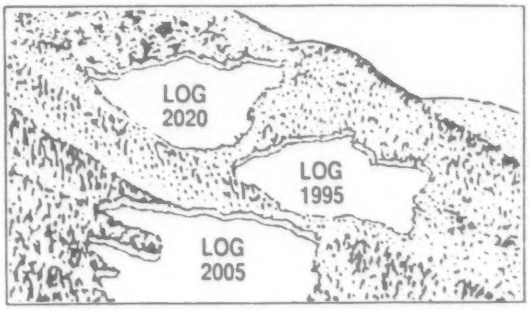


Figure 121. Sequential logging to provide forage can enhance summer ranges.

Summary of the Deep Snowpack Zone

Deer: winter

SEASONAL RANGE LOCATIONS

- Deer winter range is usually on southerly aspects with steep slopes (≥40%) exposed to winter sun.

COMMON HABITAT PROBLEMS

- Many critical winter ranges lack good habitat because clearcut areas and dense young forests regenerated after logging do not provide adequate forage and cover. Also, many potential critical winter ranges have no spring ranges nearby.

HABITAT MANAGEMENT EMPHASIS

- Retain existing old-growth forests on sites with topography of optimum and moderate value.
- Where all old growth has been removed, experiment with creating appropriate stand structures (including lichen establishment) in young growth on topography of optimum value having understory types with high potential for forage production.

COMMON HABITAT MANAGEMENT TECHNIQUES

- Defer harvesting of old growth.
- Use thinning in winter range creation experiments.

CAUTIONS

- Incorporate rock outcrops and other natural openings, whenever possible, in experimental treatment areas.
- Monitor effectiveness of experimental treatment areas and postpone harvesting adjacent areas until deer use the managed winter habitat during severe winter conditions.

Elk: winter

SEASONAL RANGE LOCATIONS

- Elk winter range is located on two distinct topographic types: lowland gentle slopes (with slopes between 0 and 10%) and adjacent upland south-facing slopes (usually on southerly aspects with slopes of 10-50% exposed to winter sun).

COMMON HABITAT PROBLEMS

- As with critical winter ranges for deer, many elk winter ranges lack good habitat because dense young forests regenerated after logging do not provide adequate forage and cover in close proximity.

HABITAT MANAGEMENT EMPHASIS

- Maintain existing old-growth forests when managing snow interception cover on the lowlands (and upland south-facing slopes when applicable), or create snow interception cover in young growth, or do both.

COMMON HABITAT MANAGEMENT TECHNIQUES

- Techniques usually focus on creating an interspersion of forage and cover areas through space and time, often by a combination of clear-cutting small blocks and thinning.

CAUTIONS

- Protect special habitats (rock outcrops, riparian areas, wetlands) from disturbance with adjacent snow interception or security cover. Visual screens may be required to buffer special habitats from human activity, such as main haul roads.
- Monitor effectiveness of treated areas and postpone harvesting adjacent areas until elk use the managed winter habitat during severe winter conditions.

Deer and elk: spring

SEASONAL RANGE LOCATIONS

- Spring range for both deer and elk is usually on southerly aspects with steep slopes (≥40%). In addition, elk regularly use riparian areas and wetland special habitats during the spring.

COMMON HABITAT PROBLEMS

- On many potential spring ranges, growth of forage species is limited by the closed canopies of dense young forests.

HABITAT MANAGEMENT EMPHASIS

- Create forage areas close to winter ranges to provide abundant, nutritious forage in the early spring.

COMMON HABITAT MANAGEMENT TECHNIQUES

- Techniques usually focus on creating forage beside cover areas either by sequentially harvesting and burning small cutblocks, or by thinning stands which still have abundant spring forage species in the understory.

CAUTIONS

- Check that adequate security and thermal cover are present next to planned forage areas.
- Protect special habitats (especially riparian areas and wetlands for elk) from disturbance by siting roads and harvesting activities well back and maintaining a visual screen.

Deer and elk: summer

SEASONAL RANGE LOCATIONS

- Summer range for both deer and elk is found on all aspects and slopes.

COMMON HABITAT PROBLEMS

- Many potential summer ranges have old growth or young dense forests with closed canopies that provide little forage.
- Disturbance of elk cows and their new-born calves is a concern in some areas.

HABITAT MANAGEMENT EMPHASIS

- Focus efforts on producing forage on appropriate understory types with cover nearby, and on protecting special habitats during forestry activities.

COMMON HABITAT MANAGEMENT TECHNIQUES

- Forage can usually be provided as a by-product of planned logging operations. However, in areas where logging is not anticipated in the near future, thinning stands having an understory of preferred forage species can also provide summer forage.

CAUTIONS

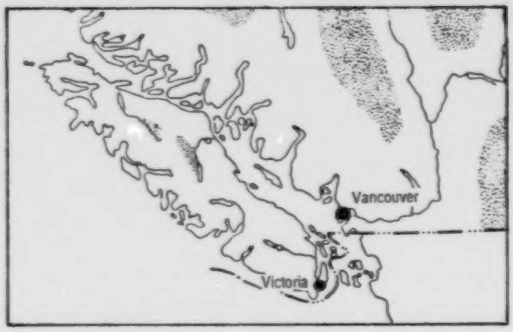
- Check that adequate security and thermal cover are present next to planned forage areas.
- When possible, before deciding where to locate treatment areas, identify elk calving areas and protect them from disturbance (between May 15 and July 15).
- Protect special habitats, especially wetlands and vegetated slides, from disturbance by siting roads and harvesting activities well back and maintaining a visual screen.

APPLYING TECHNIQUES IN THE VERY DEEP SNOWPACK ZONE

The very deep snowpack zone usually lies above 800 m elevation and encompasses high-elevation commercial and subalpine forests and alpine areas (Figures 14 and 122). Deep snow and severe winter and spring weather conditions usually preclude deer and elk use except in the summer months.

Habitat problems are not widespread in this zone because large areas of subalpine forests provide excellent forage and cover. In addition, abundant special habitats such as vegetated slides are present. Because habitat manipulation to improve forage and cover is only needed in specific locations, the main management focus in this zone is on protecting special habitats during harvesting operations.

On the following pages the most common summer range habitat problems and opportunities are described, desirable forage and cover patterns are explained, an example of habitat management is shown, and common techniques are outlined.



Very Deep Snowpack Zone Characteristics

Elevation: usually above 800 m

Maximum snow depths: often >60 cm; lasting most of the winter

Frequency of critical snowpacks (depth of snow ≥45 cm for ≥30 days): almost every year

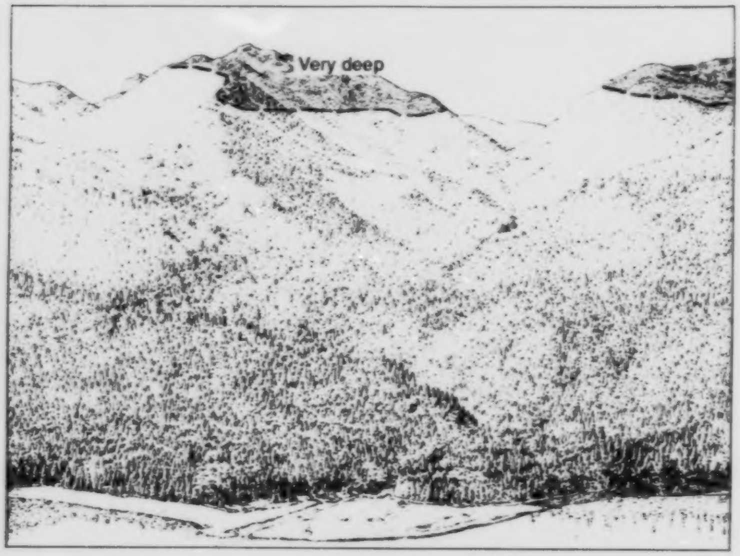


Figure 122. A schematic illustration of the location of the very deep snowpack zone.

Managing Deer and Elk Summer Range in the Very Deep Snowpack Zone

What are the common habitat problems?

Few habitat problems exist at these high elevations because less logging has occurred there than at lower elevations, abundant forage and cover are present in the subalpine forests, and forage is readily available in vegetated slides and alpine and subalpine meadows (Figure 123).

Elk calving areas are not usually found in this snowpack zone because animals arrive at these high elevations after calves are born.

What is required?

When insufficient forage is present in localized areas, forage areas can be created by either:

1. sequentially harvesting a series of cutblocks to ensure that a continuous supply of forage (especially herbs and shrubs) is produced in clearcuts and early successional stages; or
2. heavily thinning one or more young stands, thinning more lightly but repeatedly, or maintaining specific openings within the stands. Note that such management will only be worthwhile in stands that presently support at least some preferred forage species.

The first option will be used more often as more old growth is scheduled for harvesting in this snowpack zone. This will provide an opportunity to disperse logging over large areas to produce a diverse mosaic of cover and forage. In most areas, thinning of the poor quality forest sites would not be economically feasible.

Where and how can stands be managed?

Treating sites with understory types having high potential for forage production (see p. 183) and protecting special habitats (especially subalpine and alpine meadows and vegetated slides) will achieve the greatest benefit. However, all topographic positions and understory types can benefit as long as adequate security and thermal cover are available adjacent to forage areas.

The next five pages are designed to help you decide where and how to manage summer habitat. An example on the next two pages depicts one possible approach for managing summer habitat, suggests a sequence for determining treatments, and shows where relevant information can be found. A two-page graphic follows, illustrating the desired distribution and type of forage and cover areas. Finally, techniques suitable for managing summer habitat are explained on page 184.

Summer Range Parameters

Slope: all slopes
Aspect: all aspects
Special considerations: none

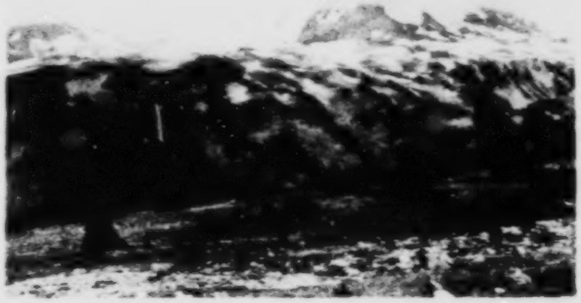
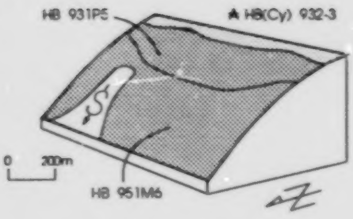


Figure 123. High-elevation areas seldom have shortages of forage or cover.

An Example of Summer Range Habitat Management

Objective: To provide a balance of summer forage and cover for deer and elk



FIRST: ***Identify habitat problems and opportunities (using pp. 182-183).***

Forest types:

- Old-growth stand of mountain hemlock and amabilis fir (HB 951M6*)
- Subalpine forest of non-merchantable old-growth mountain hemlock and amabilis fir (HB 931P5)
- Subalpine parkland (Figure 124) of mixed meadows and non-merchantable forest (ȺHB[Cy] 932-3)

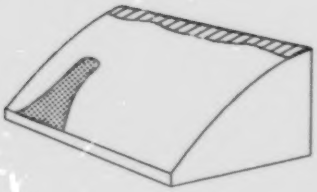
Successional stages:

● Old Growth with variable (60-90%) crown closure

○ Old Growth with variable (20-40%) crown closure

Habitat problem:

Although adequate security and thermal cover are present, little forage is available for deer below the subalpine forest.



SECOND: ***Map understory types and special habitats and known elk calving areas (using pp. 182-183 and Appendix 1 [p. 239]).***

Understory types:

○ Huckleberry - Moss understory type (high summer forage potential for deer, moderate for elk)

▨ Sitka valerian - Arnica understory type (moderate summer forage potential for deer)

Special habitats:

● Vegetated slide

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[*] The codes for forest cover types are explained in Appendix 5 (p. 293).

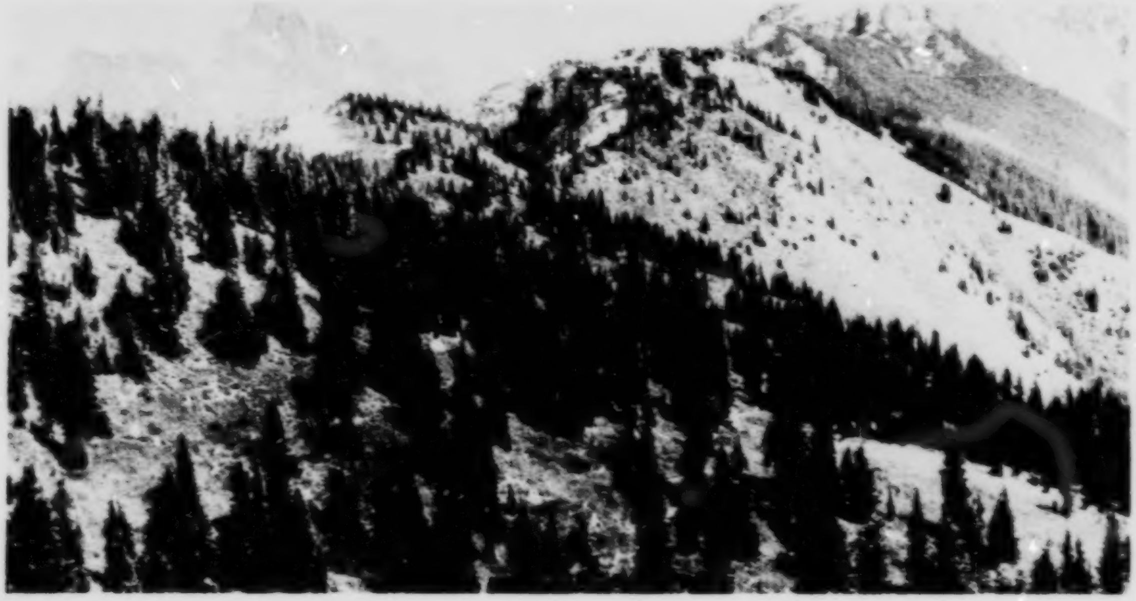
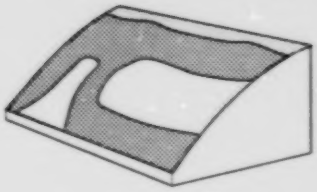


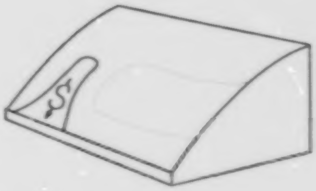
Figure 124. Subalpine parkland provides abundant forage and scattered patches of security and thermal cover.



THIRD: ***Determine desired forage and cover pattern (using the following two pages).***

Additional forage can be created within the commercial stand because the understory type (Huckleberry - Moss) has good forage potential for both deer and elk.

○ Forage area
● Security and thermal cover area
○ Forage area with scattered cover



FOURTH: ***Determine treatments (using the next two pages and the "Techniques for Managing Forage" table on p. 190).***

Habitat management strategy:

Harvest some old growth to increase the forage supply. Future cutblocks planned nearby will provide forage later, so no further treatments will be conducted within the area depicted in the illustration in the near future.

Treatments:

Year 1 - Harvest some merchantable old-growth timber (HB 951M6) on the Huckleberry - Moss understory type to obtain good forage availability. Retain cover adjacent to the vegetated slide and subalpine parkland special habitats.

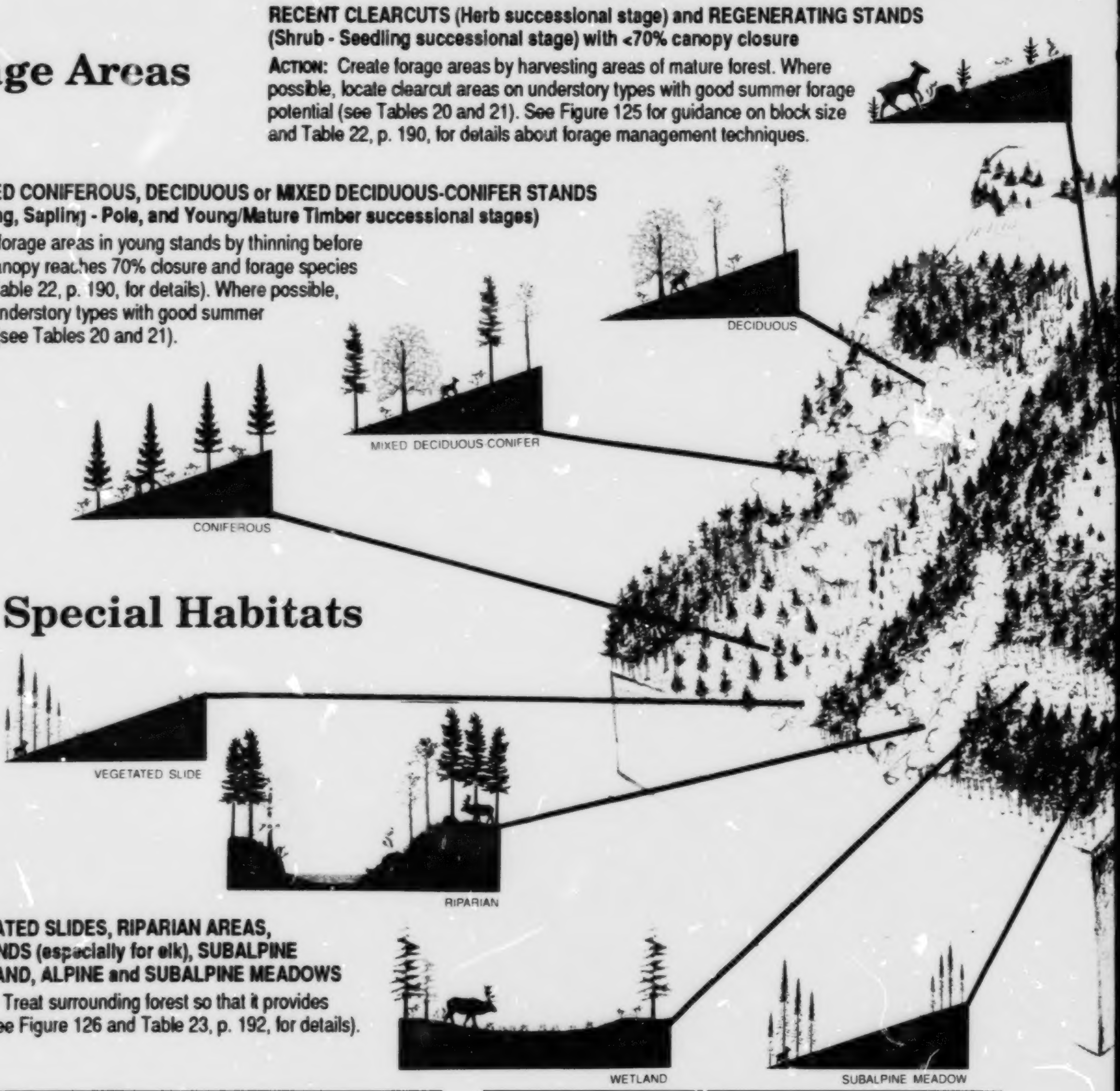
Distribution of Forage and Cover for Deer and Elk on Summer Ranges

Optimally, forage areas no more than 400 m wide would be interspersed with cover areas 100-500 m wide (see Figures 125 and 126 below).

Manage summer range areas to provide a patchwork of stands with open and closed canopies.

Good **forage** is produced in:

- recent clearcuts,
- open forests (crown closure <70%), with understory types providing preferred forage species (see Tables 20 and 21), and



Forage Areas

RECENT CLEARCUTS (Herb successional stage) and REGENERATING STANDS (Shrub - Seedling successional stage) with <70% canopy closure

Action: Create forage areas by harvesting areas of mature forest. Where possible, locate clearcut areas on understory types with good summer forage potential (see Tables 20 and 21). See Figure 125 for guidance on block size and Table 22, p. 190, for details about forage management techniques.

WIDELY SPACED CONIFEROUS, DECIDUOUS or MIXED DECIDUOUS-CONIFER STANDS (Shrub - Seedling, Sapling - Pole, and Young/Mature Timber successional stages)

Action: Create forage areas in young stands by thinning before the coniferous canopy reaches 70% closure and forage species disappear (see Table 22, p. 190, for details). Where possible, treat stands on understory types with good summer forage potential (see Tables 20 and 21).

Special Habitats

VEGETATED SLIDES, RIPARIAN AREAS, WETLANDS (especially for elk), SUBALPINE PARKLAND, ALPINE and SUBALPINE MEADOWS

Action: Treat surrounding forest so that it provides cover (see Figure 126 and Table 23, p. 192, for details).

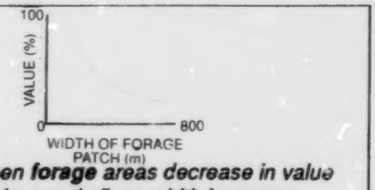


*Figure 125. Open **forage** areas decrease in value to deer and elk as width increases above 120 m.*

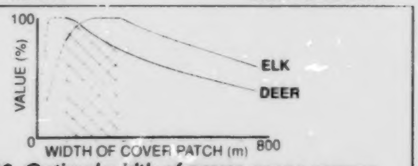


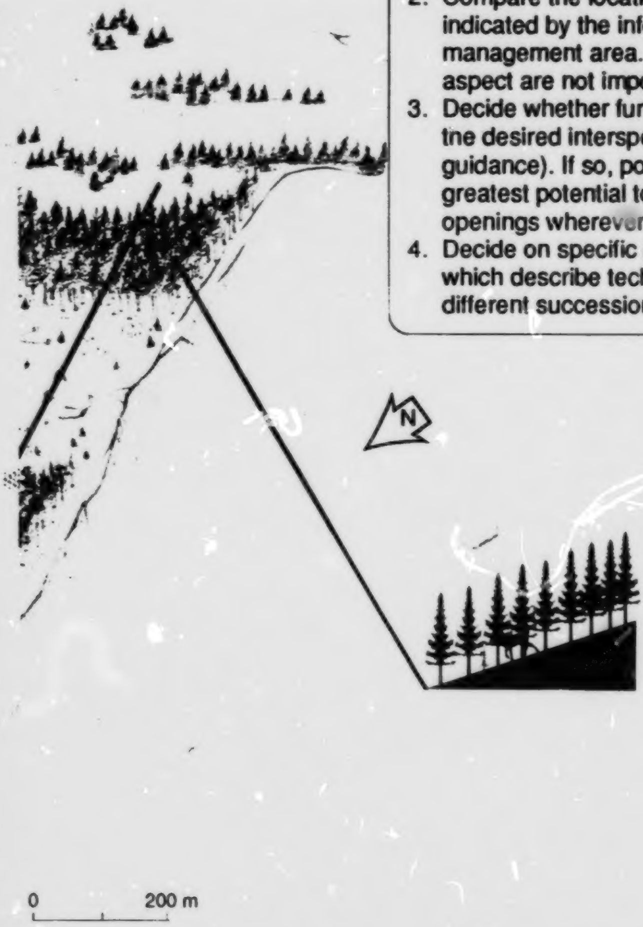
*Figure 126. Optimal width of **cover** areas ranges from 100 to 500 m.*

- the special habitats shown in the diagram.

Security cover is provided by most fully stocked forests ≥2 m high (deer) or ≥3 m high (elk). These stands also provide **thermal cover** suitable for most weather conditions. Stands ≥10 m high and with ≥70% crown closure should account for >10% of the cover area to provide thermal cover for the most adverse conditions.

How to Use this Information

1. Identify the location of any special habitats in your area and determine how you will manage them (in most cases simply protect them and provide adjacent cover).
2. Compare the location and pattern of forage and cover in your area to the "ideal" indicated by the information on these two pages or the objectives for the management area. Note that, unlike winter and spring ranges, slope and aspect are not important. Are significant improvements possible?
3. Decide whether further forage or cover areas are required to bring your area to the desired interspersion of forage and cover (use Figures 125 and 126 for guidance). If so, position forage treatments on understory types with the greatest potential to produce summer forage and take advantage of natural openings wherever feasible.
4. Decide on specific actions by referring to the tables at the end of the chapter, which describe techniques for managing forage and cover and outline how different successional stages can be treated.



Cover Areas

DENSE CONIFEROUS STANDS

Deer: (All successional stages except Herb) ≥2 m high.

Elk: (All successional stages except Herb and Shrub - Seedling) ≥3 m high.

Both: Some scattered stands, making up ≥10% of the cover area, ≥10 m high with canopies ≥70% closed for thermal cover.

ACTION: Treat so that vegetation is kept dense enough to hide 90% of a deer or elk at ≤60 m (on average) throughout the stand. In addition, maintain interspersed thermal cover. See Table 23, p. 192.

Table 20. Understory types with good summer forage potential for deer (see Appendix 1 for details)

Deer fern
Huckleberry - Dull Oregon-grape
Huckleberry - Moss
Huckleberry - Rosy twistedstalk
Indian hellebore
Oak fern
Rosy twistedstalk - Five-leaved bramble
Sitka valerian - Arnica
Skunk cabbage

Table 21. Understory types with good summer forage potential for elk (see Appendix 1 for details)

Deer fern
Huckleberry - Moss
Huckleberry - Rosy twistedstalk
Rosy twistedstalk - Five-leaved bramble
Skunk cabbage

Techniques for deer and elk summer range in the very deep snowpack zone

The techniques most commonly used on summer ranges in the very deep snowpack zone are identical to those used on both the spring and summer ranges in the moderate and deep snowpack zones. However, in this snowpack zone the emphasis is on harvesting old-growth forest to produce forage as a by-product of already scheduled forestry activities.

Efforts to improve security and thermal cover are rare because adequate cover is already available in most locations, but areas adjacent to special habitats are a concern.

The main techniques are summarized below, but managers are encouraged to consult for details the landscape illustration on pages 182-183 and the "Techniques for Managing Forage and Cover" tables at the end of this chapter (pp. 190-193).

Forage Techniques

- Clear-cut narrow blocks (<400 m wide) on appropriate understory types.
- Control debris depth.
- Encourage herbs, where soil conditions allow, by scarifying to expose mineral soil. Avoid burning on this zone.
- Once cutblocks are regenerated, limit herbicide application to spot treatments around crop trees.
- Thin to maintain <70% canopy closure if forage species are still abundant in the understory of the stand.
- Cut back and top shrubs and small western redcedar >2 m high to a height of <1 m. This encourages sprouting and increases available forage.

Figure 127. See the "Techniques for Managing Forage" table, p. 190, and the "Techniques for Managing Security and Thermal Cover" table, p. 192, to determine measures for successional stages.

Security and Thermal Cover Techniques

To prepare for future cover areas:

- Keep harvested blocks narrow (100-500 m wide).
- Maintain, wherever possible, advanced coniferous regeneration (especially shade-tolerant species such as western redcedar and western hemlock).
- Control debris depth.
- Maintain soil conditions suitable for shade-tolerant species by avoiding burning and widespread scarification.
- Plant or regenerate naturally to >500 stems per hectare. Include, whenever possible, shade-tolerant species such as western redcedar and western hemlock as part of the species mix.
- Whenever possible, choose stands with a substantial component of western redcedar and western hemlock for thinning. These shade-tolerant species should ideally constitute ≥10% of the overstory after treatment.
- Maintain cover adjacent to special habitats.

Notes

Summary of the Very Deep Snowpack Zone

Deer and elk: summer

SEASONAL RANGE LOCATIONS

- Only summer range exists at these high elevations because snow remains on the ground throughout winter and spring.

COMMON HABITAT PROBLEMS

- Logging adjacent to vegetated slides and subalpine areas may eliminate security cover for long periods of time.
- There are few other habitat problems in this snowpack zone as subalpine and alpine areas provide a diverse mix of forage and cover areas. Only in some localized areas is forage lacking.

HABITAT MANAGEMENT EMPHASIS

- Focus efforts on protecting special habitats during forestry activities.

COMMON HABITAT MANAGEMENT TECHNIQUES

- Forage is often provided as a by-product of scheduled forestry operations. Thinning would usually not be economically feasible.

CAUTIONS

- Check that adequate security and thermal cover are present next to planned cutblocks and special habitats.
- Protect special habitats (especially wetlands, vegetated slides, and alpine and subalpine meadows) from disturbance by siting roads and harvesting activities well back and maintaining a visual screen.

SUMMARY

The degree of flexibility for applying habitat management techniques varies among snowpack zones and among seasonal ranges within each snowpack zone. There are several reasons. Chief among these are the variety of habitats needed by deer and elk throughout the year, and the diversity within current forest structure as affected by past harvesting and silvicultural treatments. It is therefore important for managers to refer to the specific snowpack and seasonal range sections before deciding on treatments. A quick review of the possibilities for managing habitat in each snowpack zone is provided here.

Shallow Snowpack Zone

The shallow snowpack zone supports animals throughout the year because low snowfall and mild temperatures allow most habitats to be used in all seasons. Extensive stands of young forests, established since past logging, have created an abundance of cover but limited forage. Managers can either log small clearcuts or thin selected stands to improve the availability of food.

Because animals in this zone are not usually restricted to specific topographic sites or stands, managers have a large degree of flexibility in managing their habitat.

Moderate Snowpack Zone

In the moderate snowpack zone, animals are required to move to different topographic settings and forest types to obtain food and shelter during the different seasons. In winter, the snowfalls during severe weather force animals to seek both food and shelter in stands that can intercept heavy snows; in spring, many animals move to early successional areas where nutritious forage grows; in summer, they move to other areas where abundant food develops later in the year. In addition, much of this zone has experienced extensive logging. Young forests and clearcuts are common, and critical winter ranges have been much reduced.

Habitat management in this zone is more complex than in the shallow snowpack zone, but there is flexibility to manage spring and summer ranges by either sequentially harvesting a series of cutblocks or by thinning stands to maintain high levels of forage production. Management of winter ranges, however, is much more complicated, and managers should review pages 143-157 before deciding on treatments.

Deep Snowpack Zone

The deep snowpack zone is very similar to the moderate zone because animals seek different topographic settings and forest types to obtain food and shelter year-round. However, because snow depths are greater in the deep snowpack zone, both deer and elk rely much more heavily on old-growth timber for winter survival. Thus, although spring and summer ranges in this zone can be managed similarly to those in the moderate zone, managers should be careful to maintain old-growth stands on key deer winter range sites, and to be selective when harvesting old growth on elk winter range. Managing young forests to produce critical winter range for deer should only be done on a small-scale experimental basis until further research indicates the usefulness of these practices.

Very Deep Snowpack Zone

The very deep snowpack zone, with heavy snowfalls and a short snow-free period, is used only in the summer and early fall months. The present distribution of forage and cover at high elevations is generally good because of the extensive subalpine forests and little logging; and therefore limited habitat management is required. Logging operations in parts of this snowpack zone can provide additional forage. Managers need only ensure that special habitats such as vegetated slides and alpine meadows are protected, and that adequate security and thermal cover are provided next to cutblocks.

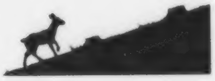
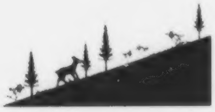
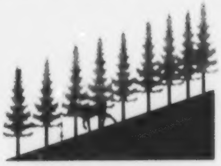
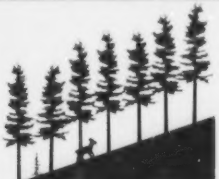
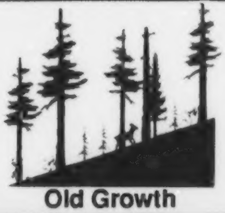
Notes

TABLES OF TECHNIQUES FOR MANAGING FORAGE AND COVER

On the following six pages are tables showing how each successional stage can be managed to produce forage and cover. Use the tables in conjunction with the landscape illustrations for each seasonal range to determine habitat management actions.

Table 22. Techniques for Managing Forage

Management objective: To produce abundant and diverse communities of herbs and shrubs to meet seasonal forage needs of deer and elk. It is best to treat stands on understory types that will produce large amounts of preferred forage species. However, treatment of most understory types will be beneficial.

A) SUCCESSIONAL STAGE		B) CONSIDERATIONS
 **Herb**	Present value:[a] • **Good** to **excellent** (abundant preferred forage species) until a dense tree canopy forms, unless dense shrubs (e.g., salal or salmonberry) or herbicide use limits herbaceous species.	Browsing may be heavy on conifers preferred by deer (e.g., western redcedar and Douglas fir).
 **Shrub - Seedling**		Forage production is optimal; it can be maintained for many years under an open forest canopy (<70% crown closure). Herbs may be overtopped by abundant shrubs.
 **Sapling - Pole**	Present value: • **Poor** (scarce preferred forage species) unless the stand has been open grown (<70% crown closure) since the Shrub - Seedling stage, in which case it will be **moderate** to **good**.	If crown closure is <70% and herbs are abundant, forage species can be retained by the maintenance of an open canopy. *Note: If crown closure is ≥70%, most spring forage will have disappeared; therefore, consider the stand as a cover area and treat accordingly (see Table 23, p. 192).*
 **Young/Mature Timber**		
 **Old Growth**	Present value: • **Poor** to **moderate** depending on the understory type and canopy closure.	Old Growth may be in short supply on south slopes, providing valuable winter range.

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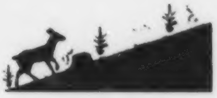
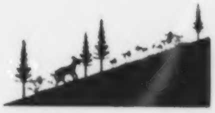
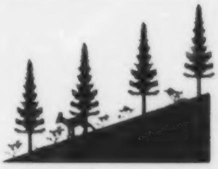
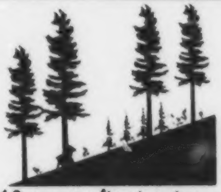
[a] Forage value on understory types with moderate to high forage potential.

[b] Grass-legume mixes have been used in Oregon to increase elk forage and reduce brush competition with trees. Seed mixtures and fertilizer rates used there (Ramsey and Krueger 1986) should be adapted to suit local conditions.

[c] For debris control during thinning:
- Fall trees parallel to each other whenever possible.
- If average debris depth is <0.3 m high, no treatment is required.
- If average debris depth is >0.3 m high and there are >25 obstacles per 100 m, consider reducing by bucking, piling, or crushing.

How to Use this Table

Look up the **successional stage** (see pp. 27-28 for definitions) you wish to treat (in column A). Read across the page, noting the management **considerations** (column B) and possible **treatments** to use (column C). **Forage value** after treatment is depicted in column D.

C) POSSIBLE TREATMENTS	D) VALUE AFTER TREATMENT[a]	
• Plant shrubs or grass-legume mixtures.[b] • Plant conifers or regenerate them naturally. • Reduce browsing damage on seedlings by planting after green-up of herbs.	• **Good** to **excellent** - abundant herbs and young shrubs	 2 years after treatment
• Limit herbicides to spot treatment around crop trees. • Cut and top shrubs and small redcedars >2 m high to a height of <1 m to increase sprouting and availability to animals.		 5 years after treatment
• Thin to maintain <70% crown closure.[c,d] • Cut and top shrubs and small redcedars >2 m high to a height of <1 m to increase sprouting and availability to animals. *Note: See p. 146 for further tips if long-term management as winter range is planned.*	**DEER:** • **Excellent** - abundant shrubs **ELK:** • **Fair** to **good** - moderate amounts of herbs except on rich, moist understory types where herbs will be abundant	 5 years after treatment  10 years after treatment
• Harvest narrow blocks (<400 m wide). • To encourage herbs (spring/summer forage), consider: - burning to reduce dense shrubs where they persist after logging,[e] *or* - scarifying to expose mineral soil. *Note: To increase forage, consider seeding cutblocks and roadsides with grasses and herbs.*[b]	• **Excellent** if logged - abundant herbs and forbs - shrubs just germinating	1 year after treatment

[d] If there is little security cover available (conifers or shrubs 2-3 m high), consider not pruning trees along edges of small openings.

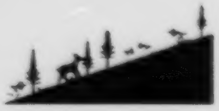
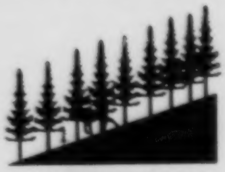
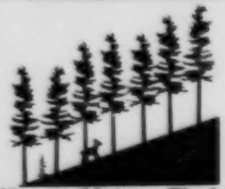
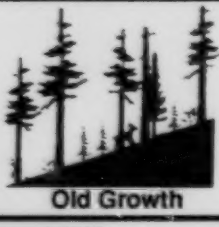
[e] Avoid burning in the very deep snowpack zone.

LEGEND

▬ herbs	▬ stumps
shrubs (<2 m)	deciduous trees
▲▲▲ conifer thickets (2-3 m)	▲ coniferous trees

Table 23. Techniques for Managing Security and Thermal Cover

Management objective: To create adequate **security** and **thermal cover** by encouraging dense stands[a] that will hide 90% of a standing deer or elk from human view at 60 m distance or less, on average, throughout the stand. Most understory types can be treated, but those with poor tree growth[b] may never provide trees of a size and density sufficient to form security or thermal cover.

A) SUCCESSIONAL STAGE		B) CONSIDERATIONS
 Herb	Present value: • **Very poor**	To establish a coniferous stand as early as possible, planting will often be desirable.
 Shrub - Seedling	Present value: • **Poor** to **excellent**, depending on density and height of conifers and evergreen shrubs.[a]	Western redcedar, western hemlock, and amabilis fir may provide dense thickets for cover and sources for future shade-tolerant understory trees.
 Sapling - Pole	Present value: • **Poor** to **excellent** depending on bole size and density.[a]	Maintenance of western redcedar and western hemlock in the stand will improve future cover possibilities on sites planned as winter ranges by providing a seed source for shade-tolerant understory conifers.
 Young/Mature Timber		
 Old Growth	Present value: • **Moderate** to **good** depending on density and height of evergreen shrubs and coniferous understory.[a]	Old Growth provides moderate to good cover; harvesting may reduce availability of winter range as well.

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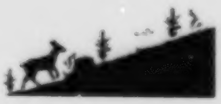
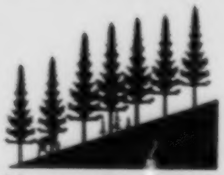
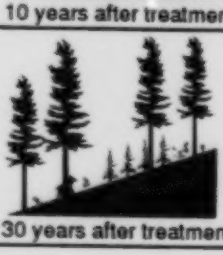
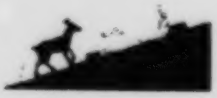
[a] Security cover is provided by most fully stocked forests ≥2 m high (deer) or ≥3 m high (elk). These stands must hide 90% of a deer or elk at ≤60 m, on average, throughout the stand. Such stands also provide thermal cover suitable for most weather conditions. Stands ≥10 m high and ≥70% crown closure should make up ≥10% of the cover area to provide thermal cover for the most adverse weather conditions.

[b] Understory types with limited tree growth:

- California brome
- Indian hellebore
- Lichen - Falsebox
- Lichen - Moss
- Lichen - Pink mountain-heather
- Lichen - Prince's pine
- Lichen - Salal
- Mountain-heathers
- Ocean-spray - Tall Oregon-grape
- Sitka valerian - Arnica
- Sphagnum
- Sphagnum - Deer fern
- Sphagnum - Hardhack

How to Use this Table

Look up the **successional stage** (see pp. 27-28 for definitions) you wish to treat (in column A). Read across the page, noting the management **considerations** (column B) and possible **treatments** to use (column C). **Security** and **thermal cover value** after treatment is depicted in column D.

C) POSSIBLE TREATMENTS	D) VALUE AFTER TREATMENT
- Plant or regenerate naturally to >500 stems/ha. Include, whenever possible, shade-tolerant species (western redcedar, western hemlock, or amabilis fir) as part of the species mix.	• **Poor** - usually inadequate cover because of small tree sizes during this successional stage.  2 years after treatment
- Avoid thinning or pruning if either will make deer or elk less than 90% hidden from view at 60 m.[a]	 no treatment
- Maintain sufficient tree density to provide tree boles and/or live limbs as security cover,[a] *or* - Ensure there is an understory component (western hemlock, western redcedar, salal, huckleberry, etc.) ≥2 m (deer) or ≥3 m (elk) high. *Note: When thinning, try to keep at least 10% western redcedar and/or western hemlock in the overstory following treatment.*	• **Excellent** - abundant shrub and conifer tree growth ensures excellent cover within a few years after treatment.  10 years after treatment  30 years after treatment
- Maintain old growth or prepare for future cover areas by harvesting blocks 100-500 m wide. - Retain advance coniferous regeneration. - Maintain soil conditions suitable for shade-tolerant species by avoiding hot broadcast burns and widespread scarification.	• **Nil to poor** if logged - only debris, a few shrubs, and scattered small conifers providing little cover will remain.  1 year after treatment

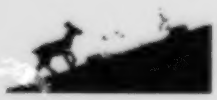
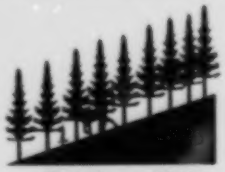
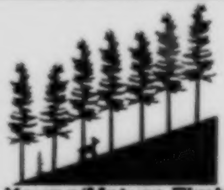
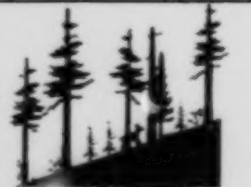
LEGEND

herbs	stumps
shrubs (<2 m)	deciduous trees
conifer thickets (2-3 m)	coniferous trees

Table 24. Techniques for Managing Snow Interception Cover

Management objective: To produce both **open** and **closed snow interception cover,**[a] containing some security cover[b] and forage,[c] within 40-80 years of stand establishment.

Stands to treat: Young stands, particularly at the Sapling - Pole successional stage, with vigorous tree growth and abundant understory forage are the best candidates. Older stands will not respond as well.

A) SUCCESSIONAL STAGE		B) CONSIDERATIONS
 **Herb**	Present value: • **Poor** - little or no tree canopy to intercept snow; little forage available when snowpack is greater than 30 cm deep	Browsing may be heavy on conifers preferred by deer (e.g., western redcedar). Browsing damage on seedlings may be reduced by planting after green-up of herbs.
 Shrub - Seedling		
 **Sapling - Pole**	Present value: • **Poor** to **moderate** - snow interception is usually poor to moderate because of small crowns - forage is poor after canopy closes beyond 70% closure - arboreal lichens[c] are absent or scarce	If crown closure is <70% and winter forage is abundant, good snow interception and moderate amounts of forage can be produced by the maintenance of a 60-70% canopy closure (i.e., **open snow interception cover**); excellent snow interception and some shrubs can be produced with a 70-90% canopy closure (i.e., **closed snow interception cover**).
 **Young/Mature Timber**		
 **Old Growth**	Present value: • **Moderate** to **excellent** if there is 60-90% canopy closure. Large trees intercept snow well, and shrubs and arboreal lichens are usually abundant.	**IMPORTANT:** This successional stage provides optimal winter range habitat. Young stands may never match the winter range value of Old Growth.

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[a] Open snow interception cover is provided by stands ≥10 m high with 60-70% coniferous canopy closure. Closed snow interception cover is provided by similar stands with 70-90% coniferous canopy closure.

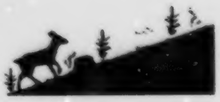
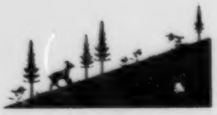
[b] For the snow interception cover to be used heavily, some security cover must be provided by combinations of tree boles, dense lower limbs, and understory vegetation or small trees ≥2 m (for deer) or ≥3 m (for elk) high. This security cover must hide 90% of a deer or elk at ≤60 m **in the winter**, on average, throughout the stand. The overhead canopy of the snow interception cover will also provide adequate thermal cover.

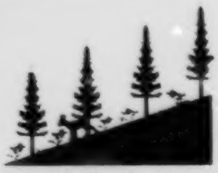
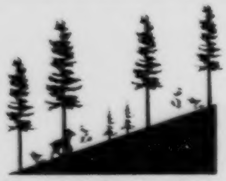
[c] In addition to rooted forage for both deer and elk, abundant arboreal lichen in the canopy is necessary for deer.

[d] Debris caused by thinning is usually not a concern because it will break down during the interval between thinning and re-closure of the canopy.

How to Use this Table

Look up the **successional stage** (see pp. 27-28 for definitions) you wish to treat (in column A). Read across the page, noting the management **considerations** (column B) and possible **treatments** to use (column C). **Snow interception value** after treatment is depicted in column D.

C) POSSIBLE TREATMENTS	D) VALUE AFTER TREATMENT	
- Where climatic and edaphic conditions allow, plant Douglas-fir and a small proportion of western redcedar (and/or western hemlock). If naturally regenerated thickets are not expected to occur, use heavier than normal stocking to establish them in selected areas.	- **Poor** in both these successional stages - trees will still be too small and the canopy too open to intercept snow effectively	 2 years after treatment
- Cut and top shrubs and small redcedars >2 m high to increase sprouting and availability to animals. - Limit herbicides to spot treatment around crop trees. *Note: Retain conifer thickets, especially around openings (see p. 146).*		 5 years after treatment

- Thin,[d,e] before canopy closure first reaches 70%, to produce 60-70% closure in areas of **open snow interception cover** and 70-90% in areas of **closed snow interception cover** after the trees reach 10 m high.
- Leave 10-15% western hemlock and/or western redcedar in the overstory for seed production to establish future thickets.
- Aim for final crop tree density of 150-300 crop trees per hectare to maximize crown volume of residual trees, unless snow interception is adequate at higher densities.
- Fertilize where needed to promote rapid tree growth and understory productivity.
- Cut and top shrubs and small redcedars >2 m high to increase sprouting and availability to animals.
	- **Moderate** to **good** once canopy closure reaches desired levels
	  - large crowns, strong branches, and closed canopies provide good snow interception and thermal cover
	  - shrubs will be moderately abundant
	  - thickets will provide security and thermal cover
		
		5 years after treatment
		
		10 years after treatment

- If old growth is to be harvested, prepare for future snow interception cover by clearcutting areas of 5-80 ha (see pp. 146-147 [deer] and pp. 154-155 [elk] for pattern). Consider not burning to retain shrubs and to maintain organic soil substrate for western hemlock and western redcedar. If burned, consider managing as a spring forage area until the canopy closes.	- **Nil**, if logged, until a young stand is established and begins to intercept snow	 1 year after treatment

[e] If there is little security cover available (conifers or shrubs 2-3 m high), consider not pruning trees along edges of small openings. Do not prune limbs with arboreal forage lichen that are >3 m above the ground.

LEGEND

herbs	stumps
shrubs (<2 m)	deciduous trees
conifer thickets (2-3 m)	coniferous trees

Chapter 6

Applying the Handbook to Habitat Management Planning

by

E.L. Richardson, R.S. McNay, J.B. Nyberg, and D.W. Janz

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INTRODUCTION

This chapter describes and illustrates a step-by-step procedure for applying the handbook to local resource use plans or 5-year development (logging) plans. These plans usually cover areas of 5000-20 000 hectares. With some tailoring, however, the procedure could also be used in identifying habitat for TSA plans or managing habitat for operational plans such as cutting permits.

The chapter is divided into two parts: a "Checklist for the Four Steps" (pp. 200-204) to ensure that users address key questions; and a reference section, "Details and Examples for the Steps" (pp. 205-236), which explains each action listed in the checklist. This reference section also includes a simplified example showing the procedure applied to a hypothetical 5-year development plan.

New field mapping and detailed documentation will seldom be required for routine applications of the handbook to 5-year development plans. Where detailed habitat analysis is needed, such as for contentious or high-capability areas in which wildlife and timber interests conflict, the process can be best applied by foresters and biologists working together as a team.

The approach described here is only one way of using the handbook and users are encouraged to tailor it to their needs when they have become fully acquainted with it.

The Planning Sequence

The recommended planning procedure, which is based on widely used resource planning methodologies (e.g., British Columbia Ministry of Forests 1983), has four steps (Figure 128):

Step 1: Identify the key habitat issues.

Step 2: Determine the potential for enhancing deer and elk habitat.

Step 3: Develop an integrated management plan.

Step 4: Schedule management activities and monitoring.

Step 1 determines where the important issues are (if there are any) and whether the handbook can be helpful. **Step 2** describes how the area **could be managed** for deer and elk habitat, while ignoring for the moment any specific land use proposals, such as logging plans. The results of this step serve as a benchmark against which the effects of proposed land uses can be assessed. **Step 3** assesses the impact of proposed land uses on the habitat and then determines how to integrate resource use. Finally, **Step 4** schedules implementation and monitoring activities.

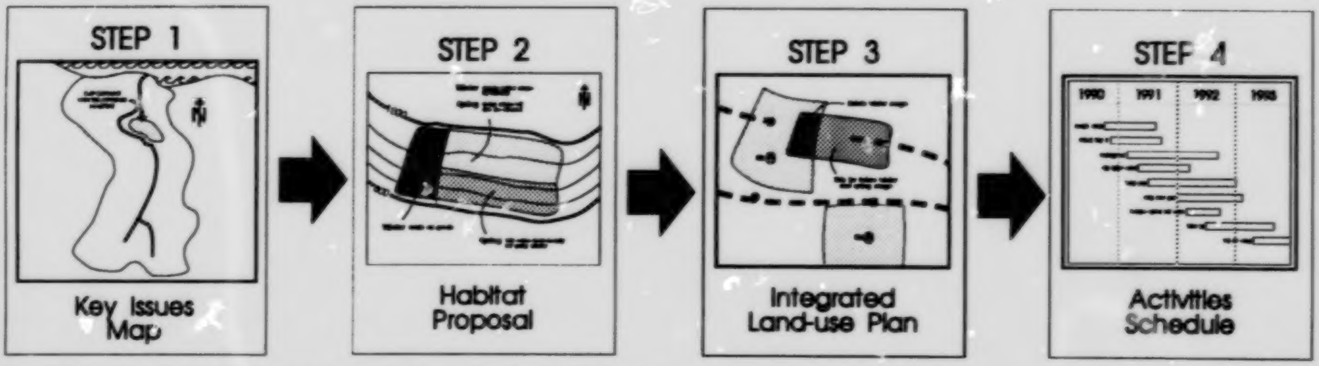


Figure 128. The four-step sequence showing the results of each step.

How to Use the Planning Procedure

In most cases, you may want to apply this chapter to forest development planning in this manner:

First: Review the **checklist** introduction (next page) and Step 1 of the checklist to determine whether applying the handbook is appropriate. Assuming it is, quickly review Steps 2 and 3 of the checklist to gain familiarity with the questions that must be answered. Then, again using the checklist as a guide, assemble the existing information needed to understand your habitat situation and how it might be affected by proposed land uses. Refer to the **step details** and **examples** as necessary (starting on p. 205).

Second: Consult with other parties (e.g., Ministry of Environment, Ministry of Forests, the forest company) to develop integrated management alternatives for the key habitat areas; choose the best one; and identify the management activities required (Step 3).

Third: Develop an implementation and monitoring schedule (Step 4).

CHECKLIST FOR THE FOUR STEPS

The checklist for applying the process is designed to be used each time the handbook is applied, not just the first time the book is read. It is the key to your understanding of the planning sequence and being able to find relevant information quickly. As such, it serves as a cross-reference to show where further details and examples may be found in the book.

Both new and experienced users should find the checklist useful in a wide range of situations involving development and review of resource use plans.

Checklist Format

Each step is summarized in a one-page list of several questions (in the coloured bars). Following each question are associated actions that will produce the answers to the questions. Each action statement provides a reference to a page in the "Details and Examples for the Steps" section (both the section number and page are noted for quick reference) where the action is explained and an example shown.

Using the Checklist

The checklist may be used in several ways, but here are two which many readers will find helpful:

1. Initially, before you are familiar with using the handbook, review Step 1 to determine whether the handbook can help you to solve your specific habitat management problem.
2. Once you are familiar with the handbook, use the checklist as a quick reference to ensure important questions are not missed, or as a cross-reference key to find further details and examples.

Working Tip: *If you plan on using the handbook frequently (e.g., for conducting referrals or developing forestry plans), you might photocopy the checklist for quick reference.*

Checklist - STEP 1: Identify the Key Habitat Issues

A. What is the goal of the planning process?

☐ **A.1.** Determine the **purpose** of the planning or referral process and confirm the **level of detail** required 207

☐ **A.2.** Define the **boundaries** of the area to be considered 208

B. Are important deer and elk habitats likely to be affected by forest management?

☐ **B.1.** Review deer, elk and timber **values** to establish importance of the area 209

☐ **B.2.** Locate important **topographic sites** and **snowpack zone** boundaries to establish habitat sensitivity 210

☐ **B.3.** Review present and proposed **land uses** and non-forest **tenures** to establish potential for habitat alteration 210

C. What are the goals, objectives, and priorities for the resources?

☐ **C.1.** Review the deer, elk, and forestry **goals**, **objectives**, and **priorities** 211

D. Is detailed habitat analysis needed?

☐ **D.1.** Describe important **concerns**, **opportunities**, and **areas** 212

☐ **D.2.** Identify **issues** requiring detailed habitat assessment 212

Checklist - STEP 2: Determine the Potential for Enhancing Deer and Elk Habitat

A. Where are the seasonal ranges with good potential for management?

☐ **A.1.** Map the **seasonal ranges** with **good potential** 215

B. How well is the forest providing habitat in the seasonal ranges with good potential?

☐ **B.1.** Identify **forage** and **cover** areas for each potentially good seasonal range.

- **B.1.a.** Stratify stands into **successional stages** 216
- **B.1.b.** Determine **crown closure** for stands 216
- **B.1.c.** Locate **special habitats** 217
- **B.1.d.** Identify **understory types** with good forage potential 217
- **B.1.e.** Assign **forage** and **cover values** to each stand 218

☐ **B.2.** Determine the portions of each potentially good seasonal range having suitable **forage** and **cover patterns** 219

☐ **B.3.** Determine the extent of **acceptable seasonal habitats** 219

☐ **B.4.** Compare the extent of **acceptable habitat** to the extent of the **potentially good seasonal ranges** 220

☐ **B.5.** Project **successional trends** in forage and cover to determine whether acceptable habitat will **increase** or **decrease** over the planning period 220

C. What opportunities exist to improve habitat?

☐ **C.1.** Decide which habitat **opportunities** and **concerns** are **important enough** for management action 221

☐ **C.2.** Outline **potential measures** to address **important habitat** opportunities and concerns 221

Checklist - STEP 3: Develop an Integrated Management Plan

A. What specific land uses are proposed?

☐ **A.1.** Map locations of proposed **land use activities** on key potential seasonal ranges 224

B. What effect would the potential habitat management measures have on proposed land use?

☐ **B.1.** Evaluate how each **habitat management measure** might affect the **proposed land use** 225

☐ **B.2.** Determine expected **effects of deer and elk** on the land use 225

C. What effect would land use proposals have on habitat and its potential for improvement?

☐ **C.1.** Project how the proposed land use will change the **successional stages**, **crown closures**, and **special habitats** 226

☐ **C.2.** Evaluate **changes** to **forage** and **cover** values and patterns 226

☐ **C.3.** Determine the extent to which the distribution of **acceptable habitat** would **change** after the land use occurs 227

☐ **C.4.** Determine how the proposed land use would affect **habitat management potential** 227

D. What is the best integrated management approach?

☐ **D.1.** Develop **land management alternatives** 228

☐ **D.2.** Assess the **alternatives** and select the plan that best meets **resource objectives** 229

E. What activities are needed to implement the selected plan?

☐ **E.1.** Specify **management activities** for the selected plan 230

Checklist - STEP 4: Schedule Management Activities and Monitoring

A. Where, when, and by whom will various activities be carried out?

☐ A.1. Prepare a **schedule of management activities** 233

B. How will the plan be monitored?

☐ B.1. Develop **monitoring criteria** for measuring success or failure 234

☐ B.2. Prepare a **monitoring schedule** 234

C. How well has the plan achieved its objectives?

☐ C.1. Evaluate the **success** of the plan based on monitoring feedback 235

☐ C.2. **Adapt** the plan to address unexpected results, changes in habitat, or revised objectives 235

DETAILS AND EXAMPLES FOR THE STEPS

This section provides detailed explanations of the questions and actions for each step and a simplified example showing how the sequence might be used to prepare a 5-year development plan for an imaginary watershed. It is designed as reference material to be used in conjunction with the "Checklist for the Four Steps" (p. 200).

In most instances, readers involved with day-to-day resource management will understand the majority of the actions listed in the checklist, and will therefore only need to use a few parts of this section to refresh their memories.

Step 1: Identify the Key Habitat Issues

This first step is designed to assist users in evaluating timber and wildlife issues to determine whether resource problems and opportunities are sufficiently important to require application of the whole procedure. Application of this step would be appropriate either when a proposed logging plan is being reviewed or when a plan is being developed before any land uses are proposed.

During this step, questions are posed about the purpose of the planning process, the resource values, the land tenure and proposed land uses, and the management goals and priorities. The aim is to determine the sensitivity and complexity of the resource issues in order to decide where in-depth habitat evaluation is required and at what points the help of a wildlife habitat specialist may be needed.

Reference materials for this step include:

- topographic map(s)
- forest cover map(s)
- land tenure map(s)
- local deer/elk capability map(s)
- 5-year development plan
- Regional Wildlife Plan

Working Tip: *This step helps you quickly screen out areas which do not require detailed analysis. You are encouraged to answer the questions after minimal research and with only approximate mapping. In many instances, you will be able to make a decision about whether or not to apply the rest of the procedure after you have contacted a few individuals who are familiar with the area.*

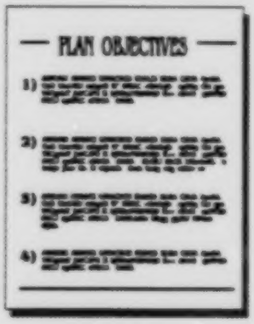
A. What is the goal of the planning process?

This question is designed to help individuals determine what the planning process will achieve so they can judge the amount of habitat analysis required. If all participants have worked together on similar processes (e.g., reviewing referrals), the question can be answered swiftly, requiring only a quick confirmation of the plan's purpose and boundaries. However, if the situation is not "standard" or if new participants are involved, taking the time to ensure there is no misunderstanding about what the plan will achieve can be a useful exercise.

Working Tip: *In situations where the plan is being prepared over a long period of time, it may be useful to quickly review the focus of the planning process at the beginning of each step. This will prevent a drift away from the original objectives as data are assembled and analyzed.*

A.1. Determine the Purpose of the Planning or Referral Process and Confirm Level of Detail Required

To avoid confusion and unrealistic expectations, all participants must understand from the outset what the planning process is expected to achieve. For example, in 5-year development plans, managers usually wish to identify all important seasonal ranges and areas which may be managed intensively for wildlife or deferred from harvesting. In TSA plans and TFL Management and Working Plans, however, the factors usually stressed are those that will affect how the AAC is calculated, such as provision of winter ranges in the moderate and deep snowpack zones; and in plans for specific sites, managers will often want to prescribe treatments for individual stands.



Example of application to the "Case Creek" watershed, an imaginary area:

A forest company had proposed a new 5-year development plan for the Case Creek watershed. Participants in the planning process agreed, since the area was Crown land, that the 5-year plan would need to incorporate integrated management of deer and elk habitat if significant issues could be identified.

Detailed plans for specific blocks might be developed later when cutting permits are being prepared.

A.2. DEFINE THE BOUNDARIES OF THE AREA TO BE CONSIDERED

All participants need to agree on the extent of the area being evaluated so that they know clearly what will or will not be addressed. Usually topographic heights of land form the logical boundaries, but managers must ensure that all relevant tenures are included within the plan area, and that habitat and activities on adjoining lands (e.g., within adjacent tenures and provincial parks) are considered.

Working Tip: *Draw in only a preliminary plan boundary first, with the expectation of revising it once the important habitat issues have been identified at the end of this step.*

Example:

The chart area boundary for the Forest License was checked. Because the chart area covered nearly all the drainage, the watershed height of land was chosen as the preliminary plan boundary.

N
Cost Creek
Height of land

B. Are important deer and elk habitats likely to be affected by forest management?

The answer to this question will indicate, first, whether important deer, elk, and timber values exist in the area; and, second, where important and sensitive habitat might be, and whether there are existing or proposed land uses and non-forest tenures which may impinge upon it.

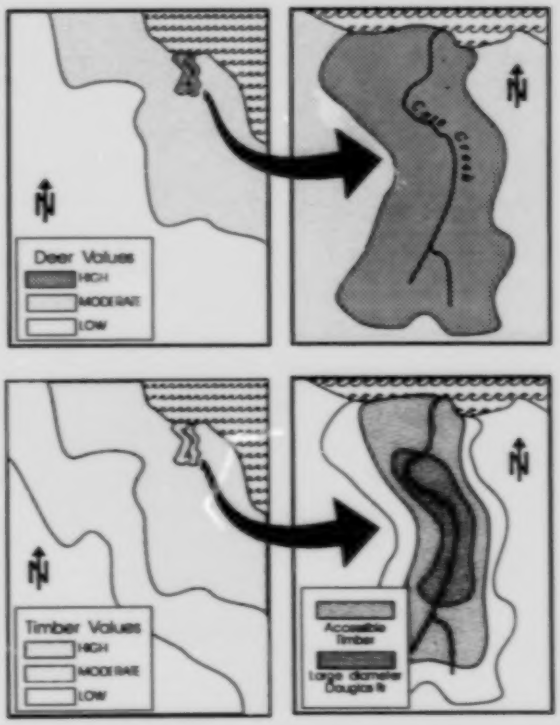
This information is critical if you are to understand the relative importance of the area, accurately identify the key habitat issues, and decide whether using the rest of the habitat assessment process is necessary. Without this information, you might begin a detailed assessment only to discover that values are very low, or that no land use is expected on sensitive habitat within the term of the plan.

B.1. Review Deer, Elk and Timber Values to Establish Importance of the Area

All participants must understand the relative resource values and management expectations when they are determining which issues are sufficiently important to address.

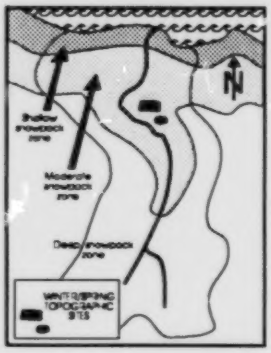
Example:

The Regional Wildlife Plan and the TFL Management and Working Plan confirmed that the Case Creek drainage has both a deer population of high value locally and regionally and high timber values throughout most of the study area. Elk are not present within the study area.



B.2. LOCATE IMPORTANT TOPOGRAPHIC SITES AND SNOWPACK ZONE BOUNDARIES TO ESTABLISH HABITAT SENSITIVITY

Roughly mapping the extent of the important topographic sites within each snowpack zone quickly indicates where the main habitat issues may be. For example, if the area is predominantly within the moderate and deep snowpack zones, it is likely that winter and spring habitat concerns and opportunities will exist.



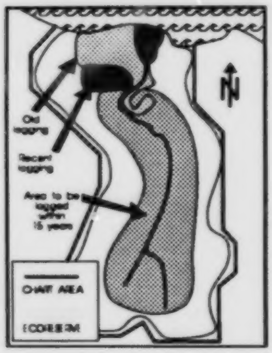
Example:

Boundaries of the snowpack zones were located with the use of the snowpack zone map and the snowpack zone table (p. 16), plus knowledge of local snowpack patterns. The important winter and spring range topographic sites were subsequently mapped on the south-facing slopes from information on the Topographic Capability table (Figure 71, p. 101).

B.3. REVIEW PRESENT AND PROPOSED LAND USES AND NON-FOREST TENURES TO ESTABLISH POTENTIAL FOR HABITAT ALTERATION

It is important to know which areas of habitat will likely be affected by land use activities in the future to identify which of the sensitive areas noted in the previous action require attention. All tenures and their associated land uses, including those surrounding the plan area, should therefore be reviewed to see if the forest cover will be changed.

In addition, the tenure types will clearly show areas where management flexibility exists. For example, manipulating habitat will be possible within a forest license but not within ecological reserves. On the other hand, forest habitat preserved on important topographic sites within parks or other reserves may mean that similar habitat can be logged in adjacent forest tenures.



Example:

Review of the land status map showed the Forest License covering all of the Case Creek drainage except an estuary ecological reserve containing only waterfowl habitat. No extensive land use activities border the study area. Some small areas in the lower valley were logged 30 years ago. Logging has occurred within the last 7 years near the estuary, and the rest of the study area which is operable is tentatively scheduled to be harvested over the next 15 years.

The sensitive sites identified in the previous action fall partly within the area proposed for logging.

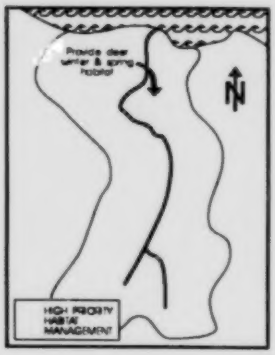
C. What are the goals, objectives, and priorities for the resources?

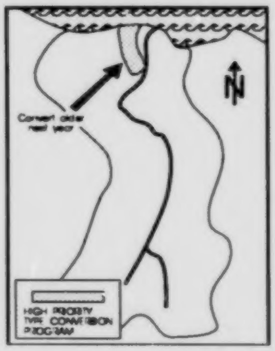
The management goals, objectives, and priorities should now be reviewed to judge whether the study area, or portions of it, warrant intensive integrated management. For example, even though an area has abundant deer, it may be assigned a low management priority if hunting pressure is currently low and is expected to remain so (e.g., due to access limitations), or if logging is proceeding slowly and maintaining a patchwork of habitats.

It is important to establish jointly agreed-to goals and objectives at this stage, as they will guide the application of the handbook through the remaining steps.

C.1. REVIEW THE DEER, ELK, AND FORESTRY GOALS, OBJECTIVES, AND PRIORITIES

If managers clearly identify what they intend to do and why, all participants can understand how resource management efforts may create potential opportunities or problems for habitat management. This information is most important when decisions are being made about which habitat issues are significant enough to require further planning effort.





Example:

Deer management in the area is a high priority because of the heavy hunting demand and high deer capability. Therefore, habitat management is also a high priority, especially for creating a balance of winter and spring habitat in the moderate snowpack zone.

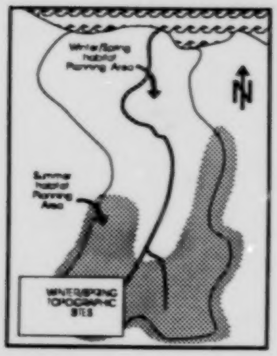
Timber management is likewise a high priority since the area is a source of large-diameter timber for several facilities. In addition, a high-priority type conversion program is planned next year in some alder stands near the mouth of the valley.

D. Is a Detailed Habitat Plan Needed?

The last question in this step involves evaluating the material assembled so far to confirm the existence and location of important habitat concerns and opportunities, and, finally, deciding how the handbook can be used to address each.

D.1. DESCRIBE IMPORTANT CONCERNS, OPPORTUNITIES, AND AREAS

All the priorities noted in C.1 should be reviewed so that only one or two obvious problems are not focussed on at the expense of other, more subtle problems which may be equally important over the long term.


Winter/Spring Habitat Planning Area
N
Summer Habitat Planning Area
WINTER/SPRING TOPOGRAPHIC SITES

Example:

Concerns and opportunities, plus a series of habitat questions, were listed, and the winter/spring range topographic sites were labelled on a map. Since elk are not known to use the valley, and since alder stands are not especially high value to deer, the alder conversion program was not a concern.

D.2. IDENTIFY ISSUES REQUIRING DETAILED HABITAT ASSESSMENT

It is important to decide which areas are important enough to expend further time and effort on. This will ensure that only those habitat issues which are critical to the achievement of management goals and objectives are evaluated.

Working Tip: *After deciding on the key habitat issues, determine whether the plan boundaries should be adjusted to address the issues adequately.*

Winter/Spring Habitat Planning Area
N

Example:

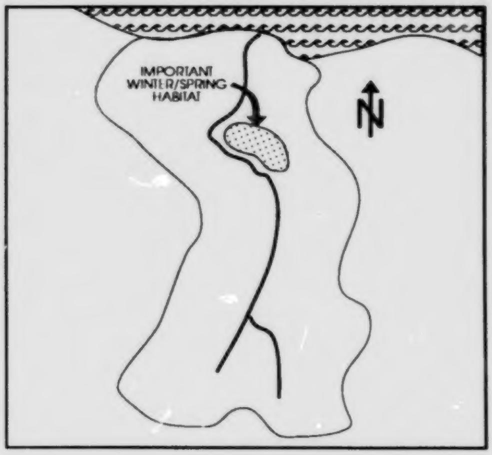
The participants jointly reviewed the concerns and opportunities and decided that the "winter/spring habitat planning area" was the only issue which would be assessed in detail because of its importance and because of the imminent harvesting planned on this important topographic site. They judged that providing summer forage in the high elevations was not sufficiently critical to require detailed assessment since little logging will occur in the near future at these elevations. They also believed that whatever harvesting does occur, regardless of location, beneficial forage will be provided.

The participants decided, however, to use the "Techniques for Managing Habitat" chapter (Chapter 5) to determine the measures and maximum size of cutblocks on summer range to protect any special habitat.

Summary of STEP 1

In answering the questions in this step, managers can save a great deal of time by eliminating those issues which do not require detailed habitat assessment. In areas with low values, low resource management priorities, or minimal proposed forest cover changes, little or no further evaluation or planning may be needed. On the other hand, by completing Step 1, resource managers of more contentious areas should now clearly understand what habitat issues require the expenditure of resources for: evaluating the existing habitat, developing potential habitat management measures, assessing the impact of the proposed land use, and designing an appropriate integrated resource management approach.

With the key habitat issues identified, users can begin the necessary habitat assessments in Step 2.

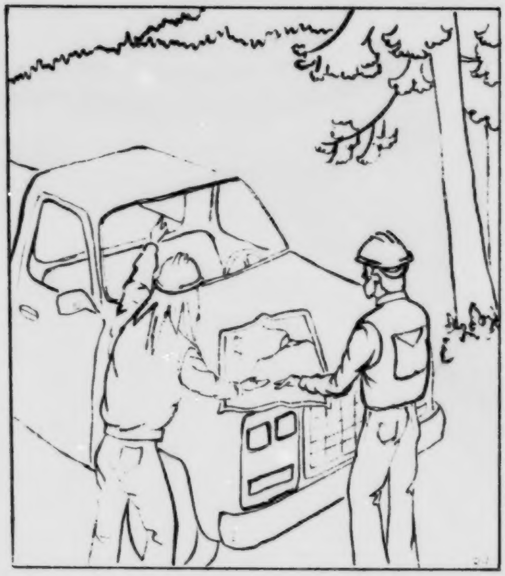


Key Issues Map

Step 2: Determine the Potential for Enhancing Deer and Elk Habitat

With the **key habitat issues** identified, users of the handbook can now determine how well the habitat is functioning and how they might wish to manage the planning area.

This step poses questions about the location of the potential seasonal ranges; about how effectively the forests on these seasonal ranges are currently providing habitat; and, finally, about what management measures might be applied to maintain or improve the habitat. Answers to these questions will help wildlife and timber managers develop long-term management plans. The information gathered provides baseline data which will be used in Step 3 for evaluating the impact of land use activities and designing integrated management approaches to accommodate both resources.



Reference materials for this step include:

- in this handbook, the "Ecology of Black-tailed Deer," "Ecology of Roosevelt Elk," and "Techniques for Managing Habitat" chapters
- topographic map(s)
- forest cover map(s)
- air photos
- biogeoclimatic and ecosystem maps (if available)
- soil/terrain maps (if available)

Working Tips: *This step is relatively complex and can be time-consuming to complete, perhaps requiring the assistance of wildlife specialists. It is therefore important to apply it only to key issues. If you have any doubt about whether it is worthwhile to expend the time and effort required to answer the questions in Step 2, check back to Step 1 to ensure the appropriate criteria were used when the key issues were decided.*

To make it easier to determine management measures for improving habitat (at the end of this step), compile a list of habitat problems and opportunities as each action is completed.

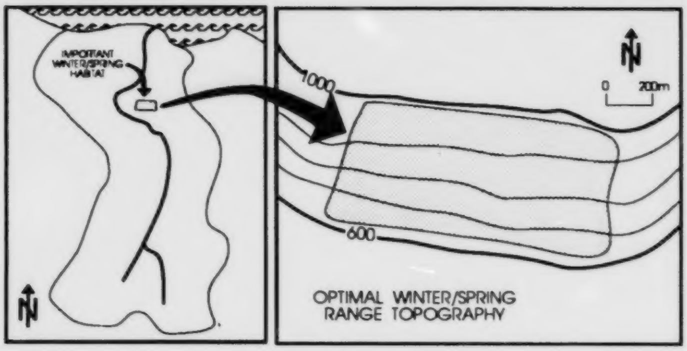
A. Where are the seasonal ranges with good potential for management?

The answer to this question will identify the locations, within the sensitive areas, of potentially good seasonal ranges. Users can thus ensure that only areas with significant potential to provide habitat are evaluated.

A.1. MAP THE SEASONAL RANGES WITH GOOD POTENTIAL

In Step 1 the approximate location of seasonal topographic sites was mapped when the key areas were identified. Now it is necessary to locate accurately the boundaries of the seasonal ranges with good potential so that only those areas having favourable slope, aspect, elevation, size, and (where appropriate) winter sun exposure are assessed for habitat effectiveness on a stand-by-stand basis. A field reconnaissance may be necessary to confirm the locations of these potentially significant seasonal ranges.

Note:* *To determine topographic criteria for seasonal ranges, see the "Distribution of Forage and Cover" landscape illustrations (Chapter 5, "Techniques for Managing Habitat") for the appropriate snowpack zone and seasonal range.


IMPORTANT WINTER/SPRING HABITAT
N
1000
600
N
0 200m
OPTIMAL WINTER/SPRING RANGE TOPOGRAPHY

Example:

One potential spring/winter range[14] located in the "spring/winter habitat planning area" (with the appropriate topographic features) is large enough (>25 ha) to be considered. It was mapped on a clear mylar overlay placed over a 1:20 000 topographic map.

---

[14] Most drainages would have more than one such area but, to keep the example as simple as possible, only one is depicted.

B. How well is the forest providing habitat in the seasonal ranges with good potential?

This question asks users to determine, for the potentially good seasonal ranges, how well the present forest cover is providing deer and elk habitat, and how natural succession will affect habitat quality.

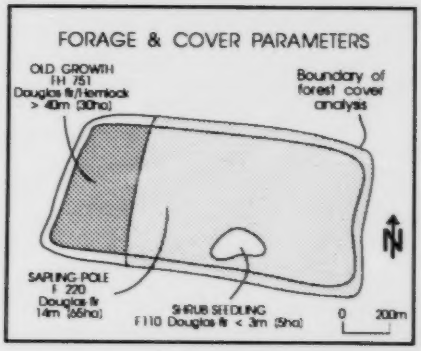
The answers provided by this question are crucial. Without them, users cannot identify where satisfactory forage and cover patterns exist. This information is also required so that users can develop (as necessary) habitat management measures at the end of this step.

B.1. Identify Forage and Cover Areas for Each Potentially Good Seasonal Range

The identification of forage (both rooted forage and lichen) and cover (thermal, security, and snow interception) areas requires the mapping of various forest parameters on overlays. These overlays are then used to rate the forage and cover values for each forest stand.

B.1.a. Stratify stands into successional stages

Each stand within and immediately surrounding (within 200 m) the key potential seasonal ranges should be stratified into one of five successional stages (see "Successional Stages," p. 27, for details) because the provision of forage or cover depends largely on stand age and height.

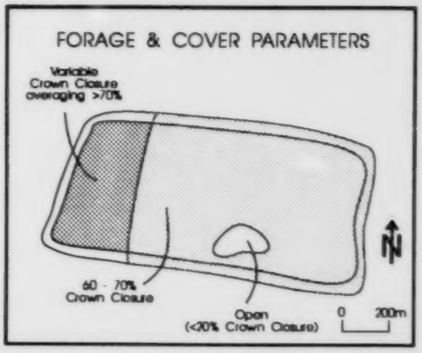

FORAGE & COVER PARAMETERS
OLD GROWTH FH 751 Douglas fir/Hemlock > 40m (30ha)
Boundary of forest cover analysis
SAPLING-POLE F 220 Douglas fir 14m (65ha)
SHRUB SEEDLING F110 Douglas fir < 3m (5ha)
N
0 200m

Example:

The successional stage classes, overstory species, and age classes (determined from forest cover maps and air photos) were noted on a "Forage and Cover Parameters" overlay for each stand within the potential seasonal range.

B.1.b. Determine crown closure for stands

Overstory crown closure dictates, to a large degree, the amount of sunlight available for rooted forage growth. Open canopies allow more forage species to germinate and flourish; closed crowns enhance snow interception, shelter from wind, rain, and cold, and shading from the sun. Thus, the identification of crown closures is crucial to understanding how well the stands may be providing both forage and cover.


FORAGE & COVER PARAMETERS
Variable Crown Closure averaging >70%
60 - 70% Crown Closure
Open (<20% Crown Closure)
N
0 200m

Example:

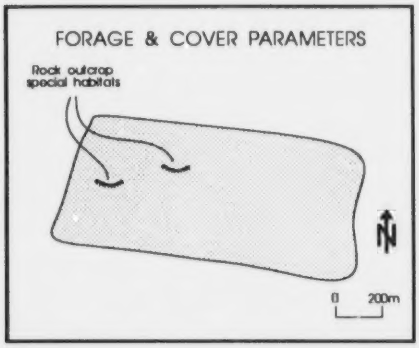
The crown closures, evaluated from the forest cover map and air photos, were noted on the "Forage and Cover Parameters" overlay.

B.1.c. Locate special habitats

Special habitats provide important forage for both deer and elk. For these areas to be used heavily by the animals, they must have adjacent security cover. Accurately locating them is therefore crucial when you are determining the suitability of cover in surrounding stands. A field reconnaissance may be needed to confirm special habitat values or boundaries.

Special habitat areas and adjacent stands may also provide a focus of some of the management measures to be developed at the end of this step.

Note: *To determine special habitats required, see the "Distribution of Forage and Cover" landscape illustrations (Chapter 5, "Techniques for Managing Habitat") for the appropriate snowpack zone and seasonal range.*


FORAGE & COVER PARAMETERS
Rock outcrop special habitats
N
0 200m

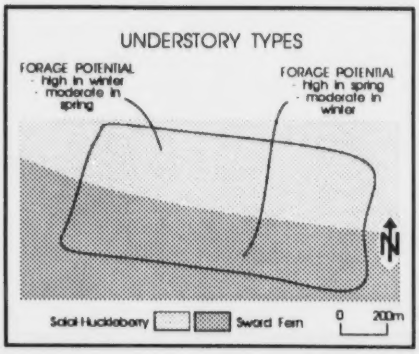
Example:

Rock outcrop special habitats were located on the air photos and noted on the "Forage and Cover Parameters" overlay.

B.1.d. Identify understory types with good forage potential

Where detailed ecosystem maps exist,[15] they should be used to identify understory types having potential to grow large amounts of preferred forage. In addition, forage management measures, determined at the end of this step, will focus on areas having the greatest potential to grow the correct forage species.

Note: *See Appendix 1 (p. 239) for details about identifying understory types.*


UNDERSTORY TYPES
FORAGE POTENTIAL - high in winter - moderate in spring
FORAGE POTENTIAL - high in spring - moderate in winter
N
Salal-Huckleberry
Sword Fern
0 200m

Example:

With the use of an existing ecosystem map and Figure 17 in the "Introduction" chapter (p. 25), the understory types were mapped on an "Understory Types" overlay.

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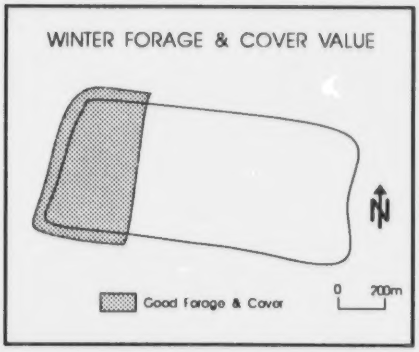
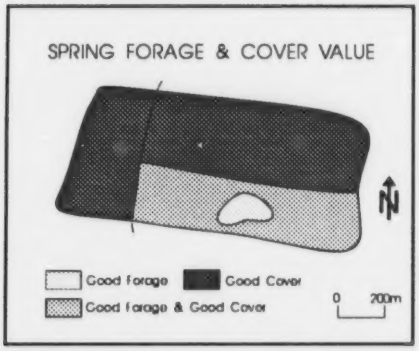
[15] Ecosystem and soils/terrain maps are not available for many areas. In such cases, managers must rely on local knowledge and field reconnaissance when attempting to identify the more favourable understory types. Even if understory types cannot be identified, however, the remaining steps can still be completed.

B.1.e. Assign forage and cover values to each stand

Mapping the forage and cover areas by using the criteria identified in the previous sub-actions provides a basis from which you can judge what proportion of the potential seasonal range has acceptable habitat, and what measures can be taken to improve the habitat.

Note: *To determine forage and cover values, see the "Distribution of Forage and Cover" landscape illustrations (Chapter 5, "Techniques for Managing Habitat") for the appropriate snowpack zone and seasonal range. Column A on Tables 22-24 (pp. 190-195) also indicates forage and cover values for each successional stage.*


WINTER FORAGE & COVER VALUE
N
Good Forage & Cover
0
200m

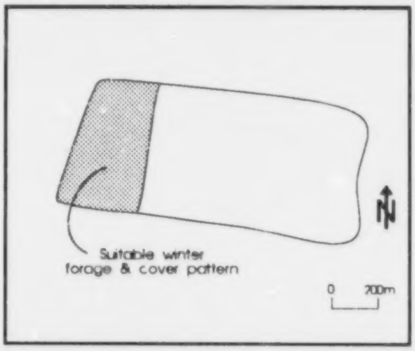

SPRING FORAGE & COVER VALUE
N
Good Forage
Good Cover
Good Forage & Good Cover
0
200m

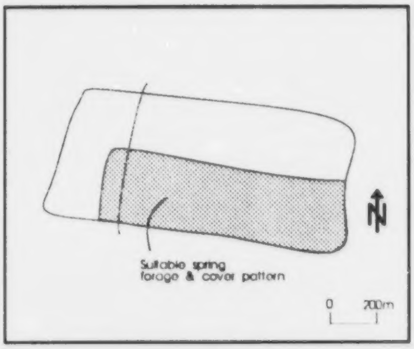
Example:

Two "Forage and Cover Value" overlays were drawn based on information provided in Figure 44 (p. 60, "Ecology of Black-tailed Deer" chapter) and Tables 22-24 (pp. 190-195). These overlays delineated the forage and cover areas for both spring and winter habitat.

B.2. DETERMINE THE PORTIONS OF EACH POTENTIALLY GOOD SEASONAL RANGE HAVING SUITABLE FORAGE AND COVER PATTERNS

Forage and cover areas must be located relatively close together for the animals to use the habitat effectively. Cover areas must also be at least 100 m wide so that animals can both hide in them and gain shelter from weather extremes (for details, see the "Ecology of Black-tailed Deer," "Ecology of Roosevelt Elk," and "Techniques for Managing Habitat" chapters). Mapping special habitats and the areas that have effective forage and cover patterns is important in identifying which portions of potential seasonal ranges are providing acceptable[16] seasonal habitats.


Suitable winter forage & cover pattern
N
0 200m

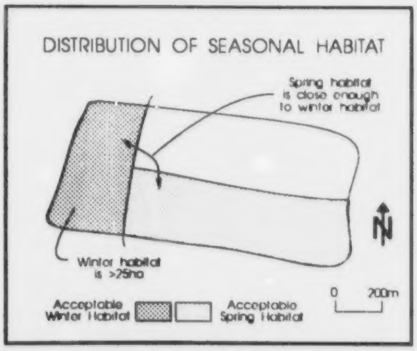

Suitable spring forage & cover pattern
N
0 200m

Example:

Two overlays (one each for winter and spring) were used to delineate areas with suitable forage and cover patterns. These were prepared according to the size and distance-to-cover criteria specified for winter and spring ranges in the moderate snowpack zone (Chapter 5, "Techniques for Managing Habitat," pp. 146-147, 160-161).

B.3. DETERMINE THE EXTENT OF ACCEPTABLE SEASONAL HABITATS

In addition to having suitable forage and cover, winter and spring habitat areas must also be sufficiently large and close enough together for the animals to use the habitat effectively. For example, if an area has only a small patch of winter habitat (< 25 ha) and no spring habitat, few animals will use the range.


DISTRIBUTION OF SEASONAL HABITAT
Spring habitat is close enough to winter habitat
Winter habitat is >25ha
N
0 200m
Acceptable Winter Habitat
Acceptable Spring Habitat

Example:

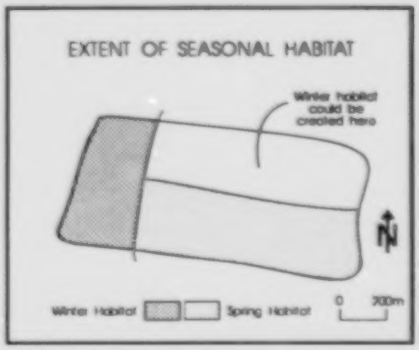
The Old Growth successional stage habitat is just large enough (30 ha) to provide acceptable winter habitat. Existing spring habitat in the adjacent young forest is close enough (Table 13, p. 147, was used to determine this) for animals to move easily between the two ranges.

---

[16] The minimum conditions necessary for a seasonal range to be considered "acceptable" will vary with local conditions, and must be judged by wildlife and forest managers in each planning area.

B.4. Compare the Extent of Acceptable Habitat to the Extent of Potentially Good Seasonal Ranges

By comparing the acceptable seasonal habitats (deduced from the current forest structure) to the potential seasonal ranges (deduced from topographic criteria), you can identify the area that could be managed to improve habitat.


EXTENT OF SEASONAL HABITAT
Winter habitat could be created here
N
Winter Habitat
Spring Habitat
0
200m

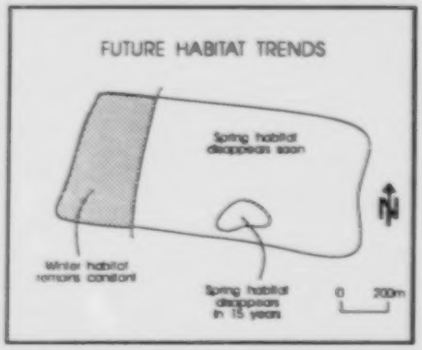
Example:

A relatively small portion of the potential winter and spring range is presently providing acceptable winter habitat. A potential exists to expand the winter habitat through habitat manipulation.

Less than half of the potential winter and spring range is currently supplying spring habitat. If the remainder of the young growth were heavily thinned as part of a regime to create additional winter habitat, this young growth could also furnish additional spring habitat until canopies close. However, understory plants, topographic variability, or conifers would have to provide sufficient security cover.

B.5. Project Successional Trends in Forage and Cover to Determine Whether Acceptable Habitat Will Increase or Decrease Over the Planning Period

Changes in successional stages over time will affect the ability of the forest to provide forage and cover. Areas with acceptable forage and cover patterns today may not provide the same seasonal range habitat in the future. It is important, therefore, that you estimate the quality and amount of acceptable habitat which may occur as a result of natural succession.


FUTURE HABITAT TRENDS
Spring habitat disappears soon
N
Winter habitat remains constant
Spring habitat disappears in 15 years
0
200m

Example:

Within a relatively short time the canopy within the Sapling - Pole successional stage will close, eliminating much of the rooted forage and decreasing the extent of spring habitat. A similar process will occur over a longer time (~15 years) in the Shrub - Seedling successional stage. Therefore, within approximately 15 years, if natural succession proceeds without management intervention, all spring habitat will disappear.

On the other hand, the Old Growth successional stage will remain unchanged for many years if it is left undisturbed by man or natural catastrophes such as wildfire. Thus, the winter habitat will probably remain constant.

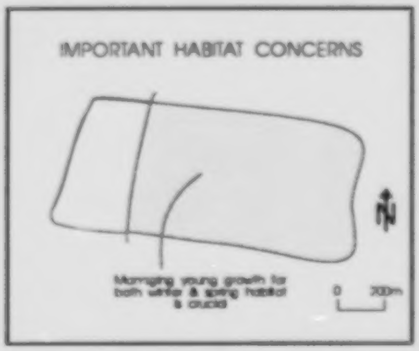
C. What opportunities exist to improve habitat?

With an understanding of the amount of acceptable habitat available and of the habitat trends over at least the next 20 years, users of the handbook can now identify where problems may occur, what opportunities may be available to improve the habitat, and what habitat management measures may be feasible.

This information will be used in the following step when the effects of proposed land use on habitat and potential habitat management measures are assessed.

C.1. Decide Which Habitat Opportunities and Concerns Are Important Enough for Management Action

Foresters and biologists often have several options available for maintaining or improving habitat. However, because time, money, and manpower are limited, individuals usually focus only on the key habitat issues.

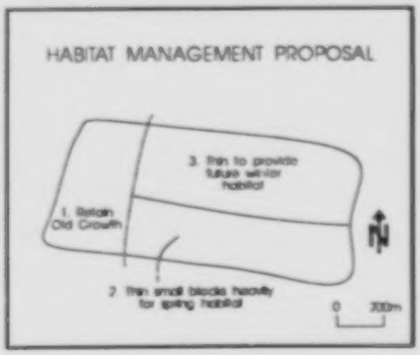

IMPORTANT HABITAT CONCERNS
Managing young growth for both winter & spring habitat is crucial
N
0
200m

Example:

Managing the only potential winter/spring seasonal range in the drainage is critical for maintaining and enhancing the deer population.

C.2. Outline Potential Measures to Address Important Habitat Opportunities and Concerns

A descriptive list of the feasible measures available for managing habitat clarifies the choices available and the trade-offs to be made among them. A habitat management proposal can then be developed with selections from the list.


HABITAT MANAGEMENT PROPOSAL
3. thin to provide future winter habitat
1. Retain Old Growth
2. thin small blocks heavily for spring habitat
N
0
200m

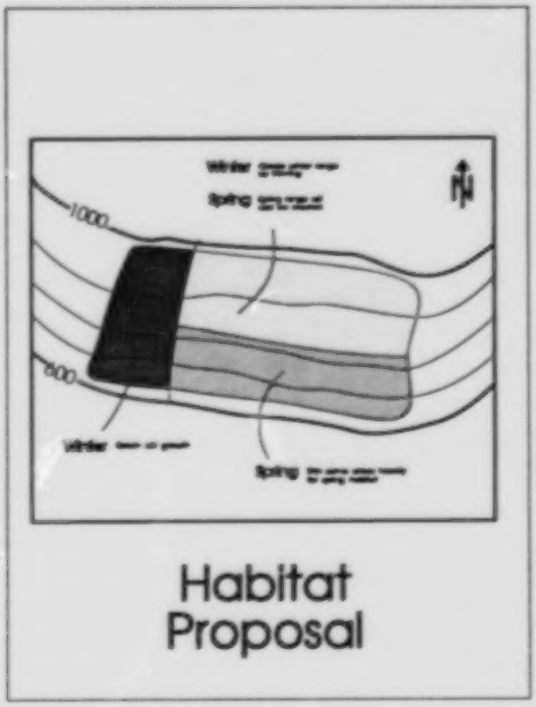
Example:

After considering options available, wildlife managers proposed to:

1. retain the old growth presently providing winter habitat;
2. immediately thin heavily a series of small blocks (~10 ha in size) in the Sapling - Pole successional stage growing on the Sword fern understory type, to provide spring habitat; and
3. manage the Sapling - Pole successional stage located on the Salal - Huckleberry understory type for future winter range by following the deer winter range creation suggestions in the "Techniques for Managing Habitat" chapter (pp. 146-147).

Summary of STEP 2

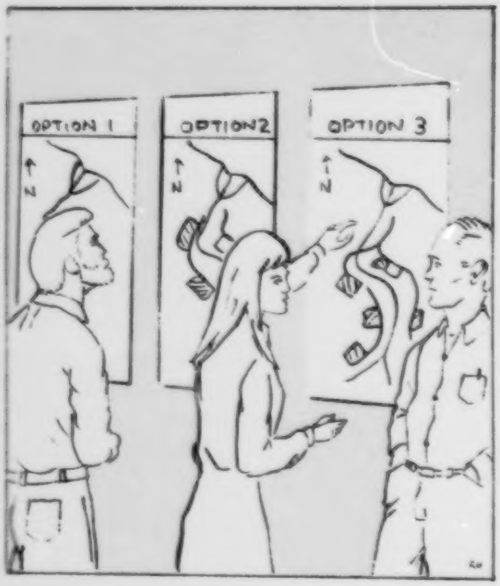
Completion of Step 2 (which culminates in preparation of a habitat management proposal) helps resource managers understand how well the forest is presently providing deer and elk habitat; how the habitat will change in the future, without any commercial land use; and how it might be managed for deer and elk habitat. This sets the stage for the following step in which the effects of the wildlife and forestry proposals are assessed.


Winter
Spring
N
1000
800
Winter
Spring
Habitat
Proposal

Step 3: Develop an Integrated Management Plan

The quality of the existing **habitat** was evaluated and **potential habitat management measures** were described in Step 2. Managers can now turn to assessing how these measures and any proposed land uses (such as logging) might affect each other. A range of land use alternatives can then be assessed, leading to development of an integrated land use plan.

This step poses questions about the specific location of proposed land uses; about how habitat management measures might affect proposed land uses; about how these land uses will alter the forest and the proposed habitat management measures developed in Step 2; about what the best integrated land use alternative is; and, finally, about what land management measures are required for the chosen alternative.



As with the preceding steps, Step 3 is designed to be used both for assessing referrals, when land use activities have already occurred in an area (e.g., in a drainage which has already been partially developed for forestry), and for planning areas which have had no previous land use activity. In the referral scenario, managers will find that answering all the questions and actions in detail will be helpful. In the latter case, where a proactive approach is used in developing an integrated wildlife and timber plan, managers can still use all the questions to determine the hypothetical effects of habitat management. This will ensure that the wildlife management program is designed to accommodate future land uses.

Reference materials for this step include:

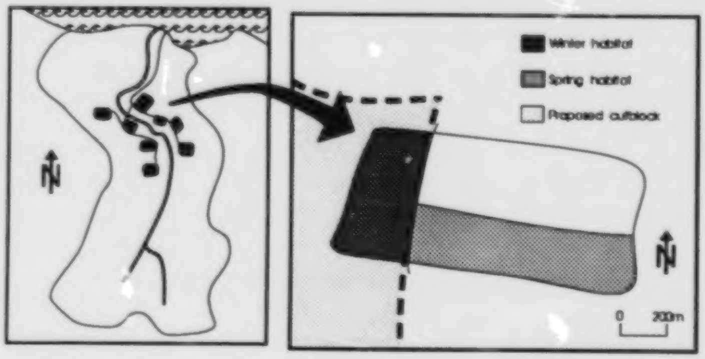
- in this handbook, the "Ecology of Black-tailed Deer," "Ecology of Roosevelt Elk," "Interactions of Timber Management with Deer and Elk," and "Techniques for Managing Habitat" chapters
- topographic map(s)
- forest cover map(s)
- air photos
- biogeoclimatic and ecosystem maps (if available)
- soil/terrain maps (if available)
- maps of tenures and proposed land uses (e.g., 5-year development plans) if applicable

A. What specific land uses are proposed?

The answer to this question will enable managers to specify the location, within the key habitat areas, of proposed land uses such as logging cutblocks and roads.

A.1. MAP LOCATIONS OF PROPOSED LAND USE ACTIVITIES ON KEY POTENTIAL SEASONAL RANGES

Before you can begin assessing the implications of land use activities on habitat, all proposed land uses must be accurately located on a topographic map (e.g., logging operability lines confirmed so as to show areas which will not be harvested; planned powerlines and public roads plotted). This will establish the relationship of the land uses to the habitat and to the locations where habitat management measures may be applied.



Example:

The old growth on the present winter range and to the northwest of the potential seasonal range was proposed by the forest company for harvest in 1991.

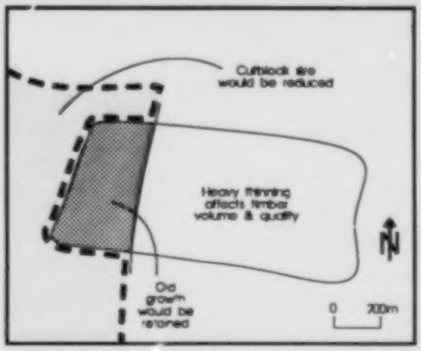
B. What effect would the potential habitat management measures have on proposed land use?

Before land use alternatives can be developed, the impact of potential habitat management measures on proposed land uses must be clearly understood so that problems (or opportunities) can be identified. The land use alternatives to be developed later can then be designed to address these problems and opportunities.

Working Tip: *To facilitate developing the land management alternatives, compile a list of problems, concerns, and opportunities which habitat management might create as each action is completed.*

B.1. EVALUATE HOW EACH HABITAT MANAGEMENT MEASURE MIGHT AFFECT THE PROPOSED LAND USE

Evaluating the effect of potential habitat management actions will allow you to define the magnitude of the various impacts (e.g., in lost opportunities to use the timber resource) and the degree of flexibility you have for compromising to accommodate these.


Cutblock size would be reduced
Heavy thinning affects timber volume & quality
Old growth would be retained
N
0 200m

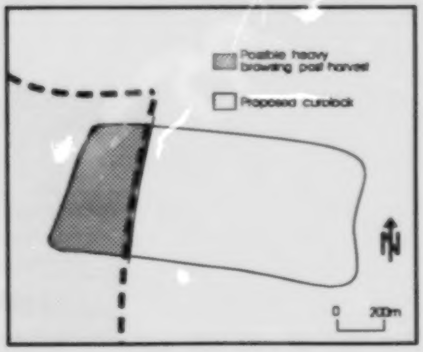
Example:

Heavy thinning for spring and winter habitat enhancement would result in long-term effects on timber volume and quality, but would have no immediate effect on the proposed logging plan.

Retaining the old growth on the present winter range would reduce the area of the proposed cutblock by 30 ha (approximately 21 000 m³).

B.2. DETERMINE THE EXPECTED EFFECTS OF DEER AND ELK ON THE LAND USE

Determining the expected effects of the deer and elk (both immediately and in the longer term) on the proposed land use (e.g., deer browsing on planted trees) will indicate whether problems can be expected and whether mitigative measures might be required.



Example:

The potential habitat measures were designed to increase the current deer population. This in turn could result in heavy browsing of planted conifers, especially in the spring.

On the other hand, if logging proceeded as proposed by the forest company, the reduction of critical winter habitat would eventually lead to reduced deer density and therefore reduced browsing pressure.

C. What effect would land use proposals have on habitat and its potential for improvement?

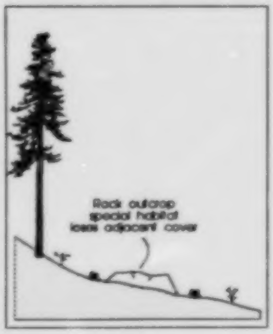
The answer to this question, essentially the converse of Question "B," will help you determine how the proposed land use will affect habitat and potential habitat management measures. It will help you clearly define problems or opportunities which may arise, and so allow you to develop a realistic set of land use alternatives.

Working Tip: *To facilitate developing the land management alternatives, compile a list of problems, concerns, and opportunities which the land use might create as each action is completed.*

C.1. PROJECT HOW THE PROPOSED LAND USE WOULD CHANGE THE SUCCESSIONAL STAGES, CROWN CLOSURES, AND SPECIAL HABITATS

Mapping the changes to the forest structure caused by the proposed land use allows you to see how the forage and cover components of each stand would change after the land use activity occurs.

Note: *See Step 2, B.1.a-c (pp. 216-217) for further explanations of successional stage, crown closure, and special habitat mapping.*



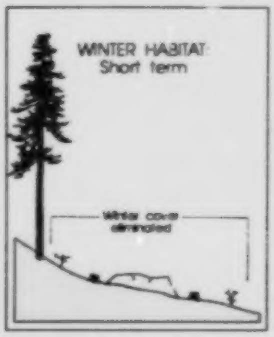
Example:

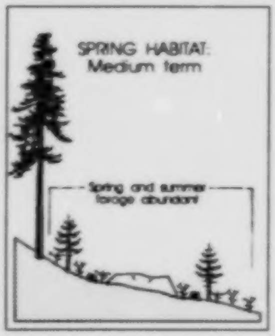
Harvesting the old growth on the present winter range would convert the area to an earlier successional (Herb) stage. The area would then have no overstory canopy or arboreal lichens, and the rock outcrop special habitat would be without adjacent cover.

C.2. EVALUATE CHANGES TO FORAGE AND COVER VALUES AND PATTERNS

This action requires determining how well the habitat would function, both immediately after the land use occurs and into the future.

Note: *See Step 2, B.1.e (p. 218) for further explanation of forage and cover rating, and Step 2, B.2 (p. 219) for explanation of effective forage and cover pattern assessment.*





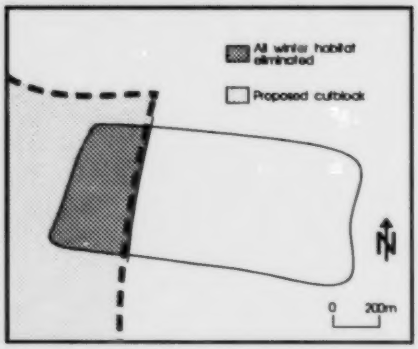
Example:

Harvesting the old growth would immediately eliminate winter cover, but would generate more spring and summer forage in a few years.

C.3. DETERMINE THE EXTENT TO WHICH THE DISTRIBUTION OF ACCEPTABLE HABITAT WOULD CHANGE AFTER THE LAND USE OCCURS

Evaluating how the amount and distribution of acceptable habitat would change as a result of land use, both in the near future and for at least the next 20 years, will show how the land use would affect the area's potential for meeting wildlife objectives.

***Note:** See Step 2, B.3 (p. 219) for further explanation of distribution of acceptable seasonal habitats and Step 2, B.5 (p. 220) for how to project habitat trends over time.*


▨ All winter habitat eliminated
☐ Proposed cutblock
N
0
200m

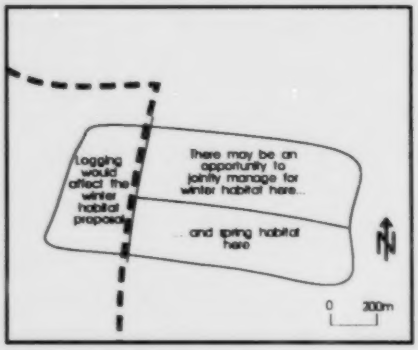
Example:

Once the old growth was harvested, there would be no acceptable winter habitat, either in the short or medium term, on the potential winter/spring seasonal range.

In the short term, spring habitat would be created, though the seasonal range is already well supplied with spring forage. Furthermore, without any winter habitat, few animals would survive to use the spring habitat if a severe winter occurred.

C.4. DETERMINE HOW THE PROPOSED LAND USE WOULD AFFECT HABITAT MANAGEMENT POTENTIAL

This action involves assessing where possible conflicts might arise and, more importantly, where opportunities to manage both resources in a complementary manner may be possible.


Logging would affect the winter habitat proposal
There may be an opportunity to jointly manage for winter habitat here...
... and spring habitat here
N
0
200m

Example:

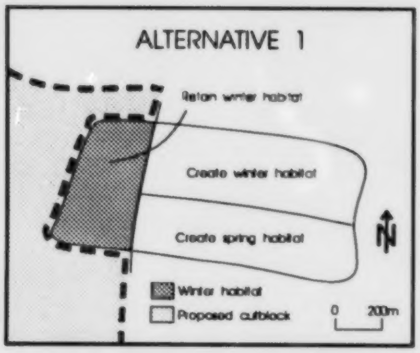
As presently proposed, the logging plan would rule out the wildlife habitat plan to retain the old growth. There may, however, be an opportunity to jointly develop a plan for managing the young growth to create winter habitat within 20-30 years and, at the same time, improve the spring habitat in the short term.

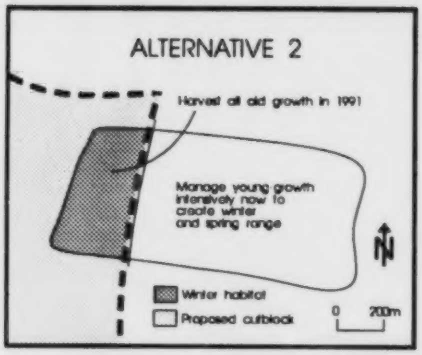
D. What is the best integrated management approach?

The lists of problems, concerns, and opportunities can now be reviewed and a series of land use alternatives which address both resources can be developed. The alternatives can then be compared and the preferred one selected.

D.1. IDENTIFY LAND MANAGEMENT ALTERNATIVES

To guide the decision process, several land use alternatives can be developed which reflect various priorities for the two resources (e.g., "pro-timber" or "pro-wildlife," and one or two compromise alternatives). From these alternatives, you can determine the potential range of costs and benefits and then pick the most appropriate alternative.


ALTERNATIVE 1
Retain winter habitat
Create winter habitat
Create spring habitat
N
Winter habitat
Proposed cutblock
0
200m


ALTERNATIVE 2
Harvest all old growth in 1991
Manage young growth intensively now to create winter and spring range
N
Winter habitat
Proposed cutblock
0
200m

Example:

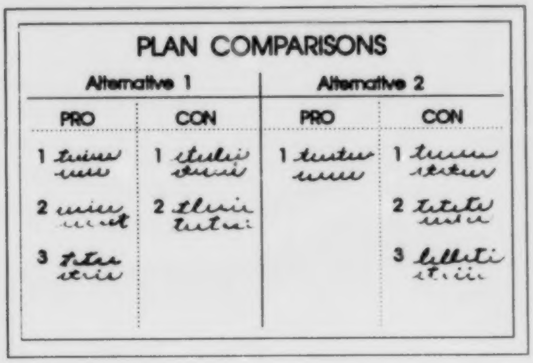
From four conceptual alternatives, including forest harvesting as proposed by the company, two were selected as most feasible:

Alternative 1: Use wildlife habitat measures as proposed by wildlife biologists in Step 2; logging of the remaining old growth is potentially possible after 20-30 years, when the young-growth stands have developed to provide critical winter range.

Alternative 2: Log old-growth winter habitat, but use silvicultural treatments to create winter and spring range in the young-growth stands.

D.2. ASSESS THE ALTERNATIVES AND SELECT THE PLAN THAT BEST MEETS RESOURCE OBJECTIVES

Assessment of a range of alternatives enables you to understand the implications of different management approaches and thus to make more informed decisions. In addition, this assessment allows you to communicate effectively the costs and benefits of different planning options to senior decision-makers and, where appropriate, the public.



Example:

The results of Questions "B" and "C" provided the basis for comparing Alternative 1 to Alternative 2. The advantages and disadvantages of each alternative were listed.

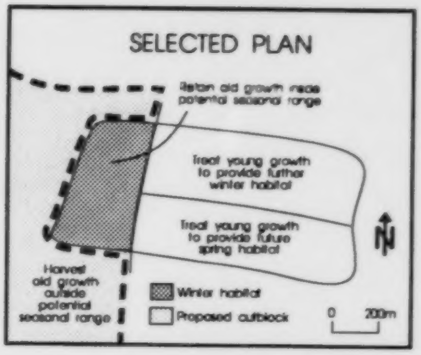
Alternative 1 was chosen because of the high deer values and because Alternative 2, developed as a compromise, would leave a long time period with inadequate winter range as the young-growth stands responded to the silvicultural treatments.

E. What activities are needed to implement the selected plan?

To complete this step, the specific management activities required for the selected plan are chosen.

E.1. SPECIFY MANAGEMENT ACTIVITIES FOR THE SELECTED PLAN

An implementation plan (as suggested in the next step) cannot be developed until the nature and timing of the specific measures required to implement the chosen land use alternative are decided.


SELECTED PLAN
Retain old growth inside potential seasonal range
Treat young growth to provide further winter habitat
Treat young growth to provide future spring habitat
N
Harvest old growth outside potential seasonal range
▨ Winter habitat
☐ Proposed cutblock
0 200m

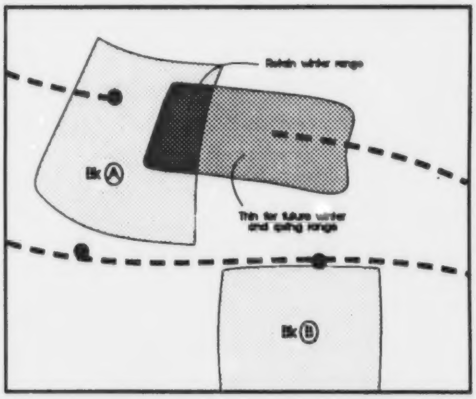
Example:

The timing of the habitat management activities devised in Step 2 was modified to fit the forest company's silvicultural schedule (i.e., young growth would be treated in 2 years rather than immediately).

Summary of STEP 3

The answers to the questions posed in this step enable managers to assess the implications of proposed land uses and decide the best mix of land use activities. Without such an assessment, it would be difficult to determine whether the habitat management as proposed in Step 2 should be implemented.

Now that a land use plan has been chosen and the activities identified for its implementation, the development of an implementation and monitoring plan can proceed (in the following step).


Retain winter range
Bk Ⓐ
Thin for future winter and spring range
Bk Ⓑ

Integrated Land-use Plan

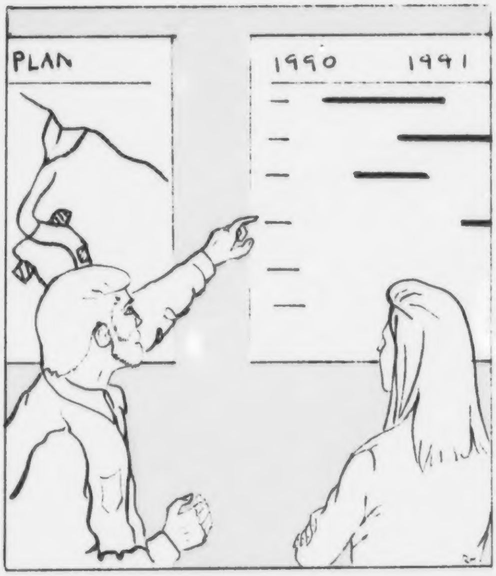
Step 4: Schedule Management Activities and Monitoring

Once the **land use plan** has been chosen and its associated **management activities** have been agreed on, all that remains is to identify how the plan will be implemented and monitored to ensure the necessary results are obtained.

This step poses questions about who will conduct the management activities; how the monitoring will be done; and, finally, how the plan will be assessed to determine whether it has achieved its objectives.

Reference materials for this step include:

- in this handbook, Chapter 5, "Techniques for Managing Habitat" (for monitoring criteria)

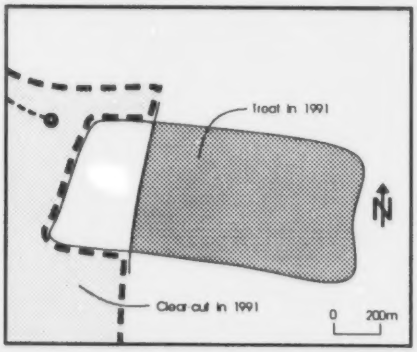


A. Where, when, and by whom will various activities be carried out?

To ensure that management activities are actually carried out, they should be assigned to the appropriate company or agency. These activities should be recognized in budgets and business plans (e.g., for the Small Business Forest Enterprise Program) so that commitments in the plan are sure to be met.

A.1. PREPARE A SCHEDULE OF MANAGEMENT ACTIVITIES

A written action plan or schedule of activities is required to ensure that measures agreed on are included in operational budgets and conducted in the right season and year. This is a routine part of virtually all land management programs.



Example:

The habitat management activities were incorporated in the 5-year development plan.

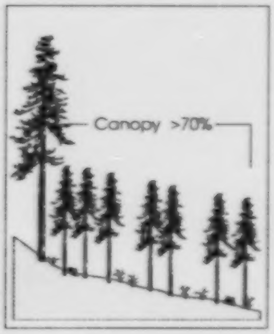
B. How will the plan be monitored?

For management programs to continue to be effective, they must be monitored. Monitoring allows managers to confirm whether the actions were conducted as planned, to determine if the expected results are actually realized, and to identify changes to the program required to correct problems or adapt to changing circumstances.

B.1. Develop Monitoring Criteria for Evaluating Success or Failure

To support a successful monitoring program, clear criteria must be established against which management results can be judged. For example, one criterion might be that canopies of young stands designated as winter range must close by a predetermined amount over a stated time period.

Note: *To determine criteria, see the "Distribution of Forage and Cover" landscape illustrations (Chapter 5, "Techniques for Managing Habitat") for the appropriate snowpack zone and seasonal range*

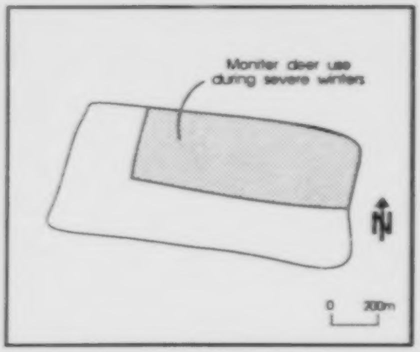


Example:

Winter forage species must be abundant in the young-growth winter habitat block and the crown closures must be >70% in 60% of the block by 2001. Deer using the stand during a severe winter must survive in relatively good condition before adjacent old growth can be logged.

B.2. Prepare a Monitoring Schedule

Preparation of a written monitoring schedule will ensure that you schedule time and funds for monitoring, and that you assess results of the management activities at the appropriate time (e.g., during severe winters).



Example:

The young-growth winter habitat block will be monitored by:

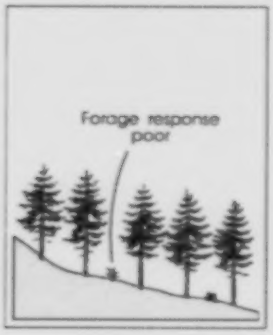
1. the Ministry of Environment for winter deer activity, starting in 2001 (10 years after treatment) and then during severe winters until the deer using it are known to survive the harsh weather in good condition; and
2. the licensee for forage and canopy responses at 5-year intervals, starting in 1996.

C. How well has the plan achieved its objectives?

Plans seldom are effective for long unless they are reviewed periodically to determine whether objectives are being met or modifications are required. It is therefore important to keep the plan "evergreen" by systematically analyzing the monitoring results and using the new knowledge to improve it.

C.1. EVALUATE THE SUCCESS OF THE PLAN BASED ON MONITORING FEEDBACK

By evaluating the success of the plan on a regular basis (e.g., in preparation for yearly 5-year development plan reviews) and documenting the results, you can ensure prompt identification of success and failure. The evaluation documents will provide a permanent record of the history of the habitat plan.

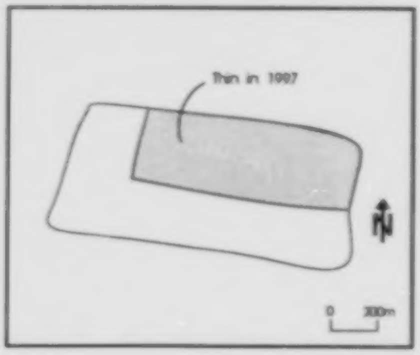


Example:

Activities to create winter habitat in the Sapling - Pole successional stage have been conducted as planned. However, monitoring in 1996 showed that forage response in the future snow interception areas was poorer than expected because thinning did not open the canopies sufficiently.

C.2. ADAPT THE PLAN TO ADDRESS UNEXPECTED RESULTS, CHANGES IN HABITAT, OR REVISED OBJECTIVES

In virtually all situations, unexpected natural phenomena such as wildfires and windthrow change the habitat during the life of a plan. Management policies and priorities also often change. Thus, for the plan to remain useful, you must adapt it regularly to rectify problems arising from management activities and unforeseen developments.

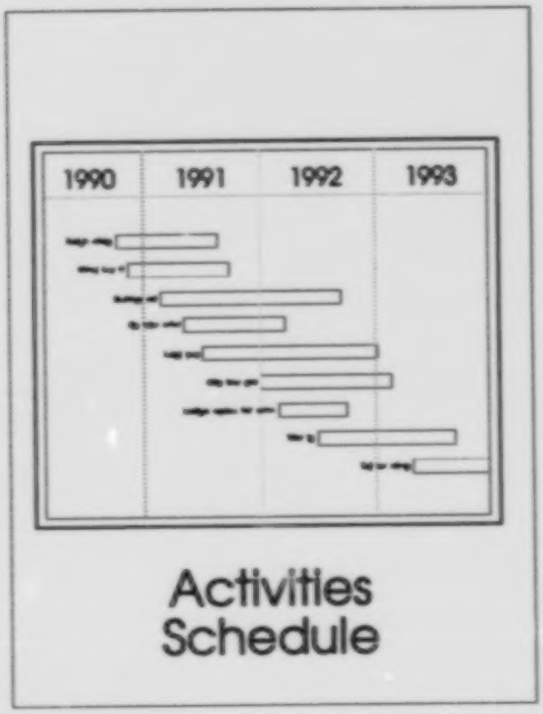


Example:

To ensure that sufficient forage is available when the winter habitat creation area begins to function, the future snow interception areas will be thinned again in 1997.

Summary of STEP 4

By ensuring that management activities are incorporated into management documents such as 5-year development plans and operational plans, by establishing a monitoring mechanism, and by using a systematic process to adapt the plan, you can be relatively confident of achieving desired results. Without this systematic approach, the plan's usefulness will drop sharply. You will be unable to detect problems quickly or to learn from mistakes before similar measures are used elsewhere.



AFTER USING THE PROCEDURE

After you have used the procedure once or twice, identify which questions and actions have been most useful and tailor the sequence so it can be applied more efficiently. During the tailoring process, take care not to eliminate questions and actions; rather, indicate which ones require only cursory attention (to ensure no point is overlooked) and which ones require detailed attention.

Once you are familiar with the procedure, expect to make more use of the checklist found on pages 201-204. You will likely only need to make infrequent references to the descriptions of each question and action contained in this section.

Finally, note that although the procedure is designed to be used on key habitat management issues, the principles detailed in other sections of the handbook (e.g., "Ecology of Black-tailed Deer," "Ecology of Roosevelt Elk," and "Techniques for Managing Habitat" chapters) can be used routinely to resolve day-to-day habitat management problems without requiring application of the procedure.

After becoming familiar with the handbook, you will no doubt have suggestions about improving it. All ideas are welcome, so please send yours to the editors at either of the addresses listed on page i.

APPENDIX 1.
UNDERSTORY TYPES[1]

The following detailed information on the 29 understory types is provided to supplement the general description in Chapter 1.

TYPE NAMES

Understory types, as defined here, are vegetation units differentiated by environmental properties. They include all plant communities that may occur on each site during succession to the climax community. The names were derived from common and dominant understory species found in the near-climax or climax plant communities, but there may be considerable variation in both the overstory and understory species among communities of different ages and different disturbance histories.

NOTES ON THE UNDERSTORY TYPE DESCRIPTIONS

Potential Forage Values: The ratings of potential forage production that appear in tables on the following pages represent estimates of the relative capability of each understory type to produce important forage plants at the type's peak of forage production. Actual forage production on any site depends on its site potential, its history of disturbance, and its current overstory condition. For most types, peak production occurs in the absence of a forest canopy, but others reach their maximum level under an open forest canopy (for example, the Salal - Huckleberry understory type).

To prepare these estimates, the understory type providing the best and most abundant forage in each season was first assigned an index value of 1.0. Indices for other understory types were then scaled to reflect relative amounts of preferred forage. Thus, at its peak of production, a type rated 0.5 would provide about half as much forage as the best type. Because the numerical estimates are of uncertain precision, indices were converted to categorical ranks of Low (indices of 0-0.4), Moderate (0.5-0.7), and High (0.8-1.0).

Understory Composition: Only the most common species occurring in each understory type are listed. Of those, species that are usually most abundant or are diagnostic of the type are printed in bold type; other species are listed in approximate order of frequency of occurrence. The letters "D" and "E" after individual plant species indicate that those species are important forage plants for deer and elk, respectively.

Value to Deer and Elk: The written descriptions of value to deer and elk consider all aspects of each understory type, including such factors as the type's ability to provide cover at certain successional stages. The descriptions do not, therefore, always correspond exactly with the entries in the forage value tables.

Forestry Effects: The response of understory vegetation to non-commercial and commercial thinning, as interpreted from field data collected on Vancouver Island (Nyberg *et al.* 1990a), is discussed for the Deer fern, Huckleberry - Moss, Moss, Salal - Dull Oregon-grape, Salal - Huckleberry, and Sword fern understory types. Effects of site preparation and regeneration are also described for some well-studied types.

HOW TO IDENTIFY UNDERSTORY TYPES IN THE FIELD

Where maps of site associations or other ecological units are already available, understory types can often be easily identified by reference to the biogeoclimatic unit, hygrotope, and trophotope information in the matrix presented with the description of each type. If such maps are not available, a site diagnosis (Green *et al.* 1984) in the field will be required before the understory type can be confirmed. The pre-harvest silvicultural assessment will often provide an opportunity for collecting the required information. Biogeoclimatic units for the handbook area were mapped by Nuszdorfer *et al.* (1985), and details of the site diagnosis procedure are described in Green *et al.* (1984).

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[1] Compiled by C.A. Ray and L.D. Peterson, Research Branch, B.C. Ministry of Forests, Victoria, B.C.

BLACK HUCKLEBERRY - WHITE-FLOWERED RHODODENDRON

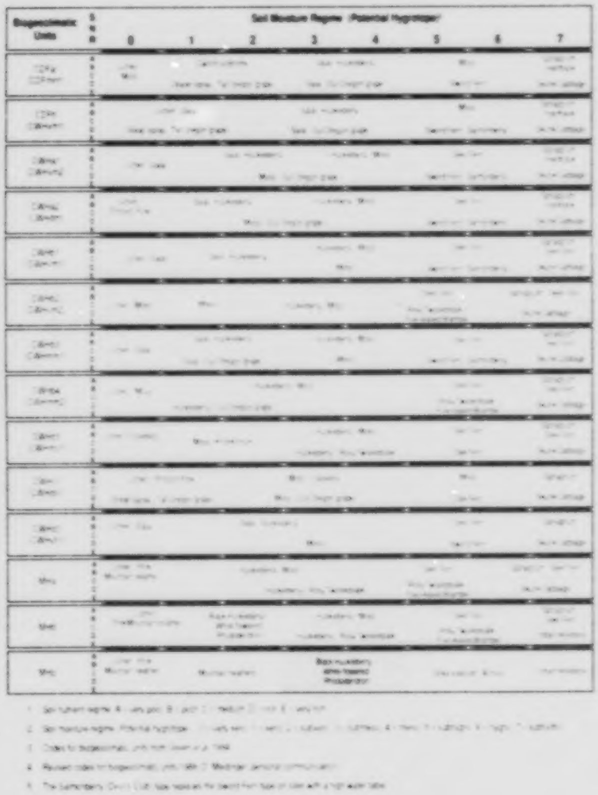


Figure 1. The position of the Black huckleberry - White-flowered rhododendron understory type on the biogeoclimatic unit/edatope matrix.

Table 1. Potential forage values, by season, for deer and elk

Species	**Season**		
	Winter	**Spring**	**Summer**
Deer	Low	Low	Low
Elk	Low	Low	Low

LOCATION: At high elevations in the mountains of Vancouver Island and the adjacent mainland

BIOGEOCLIMATIC UNITS: The Submaritime (MHb) and Parkland (MHp) Subzones of the Mountain Hemlock Zone

SITE PROPERTIES:

Soil Moisture Regime: **1-2** in the **MHb, 3-4** in the **MHp**

Soil Nutrient Regime: Very poor to very rich (A-E)

Slope Position and Soil Features: Mainly on upper slopes in the **MHb** and middle slopes in the **MHp**, with shallow to deep, medium- to fine-textured soils

STAND COMPOSITION: Mainly mountain hemlock, amabilis fir, yellow-cedar, and subalpine fir

UNDERSTORY COMPOSITION:

Shrubs: **Black huckleberry** (D), **white-flowered rhododendron, false azalea, pink mountain-heather, white mountain-heather,** alpine-wintergreen

Herbs: Bunchberry (D,E), partridgefoot, five-leaved bramble

Mosses: ***Rhytidiopsis robusta***

TIMBER VALUE: In the MHb, these sites are productive for mountain hemlock, amabilis fir, yellow-cedar, and subalpine fir. In the MHp, mountain hemlock, amabilis fir, and some subalpine fir grow in scattered clumps and are not as productive.

VALUE TO DEER: Because of the high elevation of the MHb and MHp subzones, this type is of no value to deer in the winter and most of the spring. This shrub-dominated type has a low to moderate forage potential. Species diversity is low, but increases in recent clearcuts where fireweed may invade. Deer use in spring will probably be low; delayed green-up in the montane subzone makes summer and fall the time of greater use.

VALUE TO ELK: Because this understory type occurs only at very high elevations in the area of handbook applicability, few Roosevelt elk use it. It has very low forage value during the seasons when it is accessible.

CALIFORNIA BROME

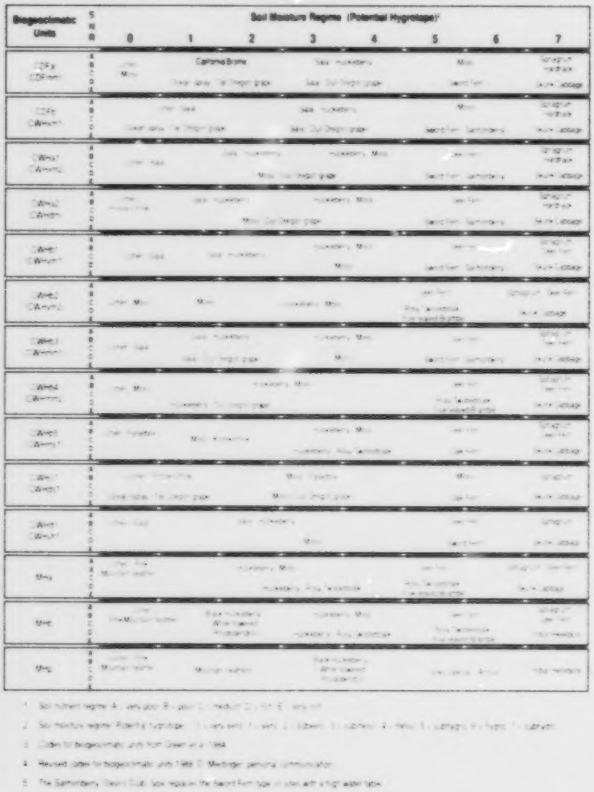


Figure 2. The position of the California brome understory type on the biogeoclimatic unit/edatope matrix.

Table 2. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Low	Moderate	Low
Elk	Low	Low	Low

LOCATION: On southeastern Vancouver Island and the Gulf Islands

BIOGEOCLIMATIC UNITS: The Drier Maritime Coastal Douglas-fir (CDFa) Subzone

SITE PROPERTIES:

Soil Moisture Regime: **1-2**

Soil Nutrient Regime: Primarily very poor to medium (**A-C**)

Slope Position and Soil Features: Mainly on ridge crests, upper slopes, flats, and gentle slopes with shallow soils over bedrock or colluvial materials; often associated with rock outcrops

STAND COMPOSITION: Scattered Garry oak and arbutus

UNDERSTORY COMPOSITION:

Shrubs: Scotch broom

Herbs: **California brome** (D,E), yarrow, vetches, field chickweed, Kentucky bluegrass (D,E), dovefoot geranium, small-flowered blue-eyed Mary, hedgehog dogstail, white fawn lily, small-flowered alumroot, small-leaved montia, sea blush, wild strawberry, California oatgrass, common camas, death-camas, Hooker's onion

TIMBER VALUE: Garry oak and arbutus have, at best, marginal timber value.

VALUE TO DEER: The understory of grasses and annual forbs is of limited value to deer because of desiccation and wilting after early summer. The dominant shrub, Scotch broom, receives heavy use on some sites. Because this habitat is found only in areas with a mild climate, deer can use the type year-round. Heaviest use of forage occurs during spring, when new plants first emerge. Use may increase again in late summer, when rain and cooler temperatures cause grasses to regrow. This type produces little winter forage.

VALUE TO ELK: Few elk have access to this understory type because of its distribution, and human development in the vicinity often reduces its attractiveness. Forage potential is minimal. Open, rocky areas with this type can provide warmth from solar radiation on sunny winter days, and perhaps some grass and forb forage.

DEER FERN

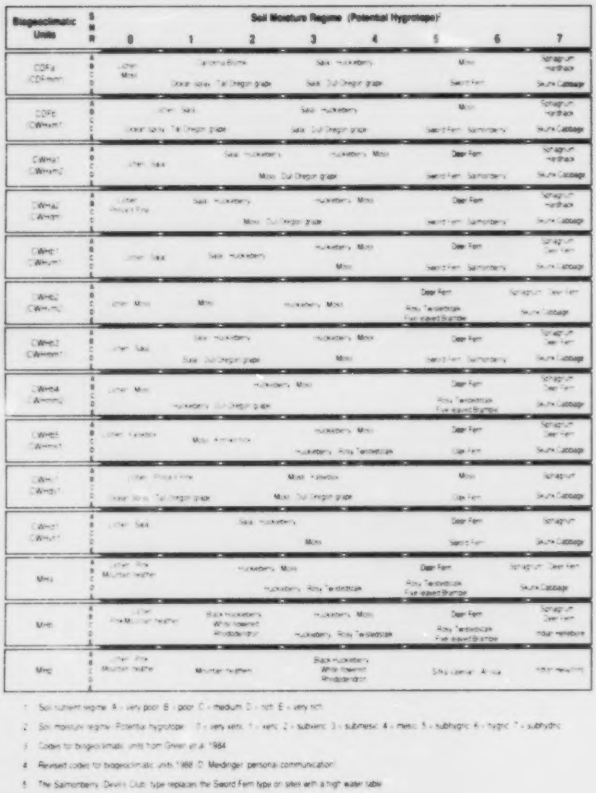


Figure 3. The position of the Deer fern understory type on the biogeoclimatic unit/edatope matrix.

Table 3. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Moderate	Moderate	Moderate
Elk	High	High	High

LOCATION: Throughout Vancouver Island and the coastal mainland, except areas with dry climates and very high elevations

BIOGEOCLIMATIC UNITS: Throughout the Coastal Western Hemlock Zone (**CWHal, CWHa2, CWHb1, CWHb2, CWHb3, CWHb4, CWHb5, CWHd**) except in the Southern Drier Submaritime CWH Variant (**CWHc1**). Also in the Forested Mountain Hemlock Subzones (**MHa, MHb**).

SITE PROPERTIES:

Soil Moisture Regime: **4-6**

Soil Nutrient Regime: Very poor to medium (**A-C**)

Slope Position and Soil Features: Mainly on lower slopes and flats with shallow to deep, mainly coarse-textured soils (morainal blankets, coarse glacio-fluvial materials, organic veneers)

STAND COMPOSITION: Western hemlock and western redcedar are dominant in most areas, except in the MHa and the MHb where mountain hemlock and yellow-cedar become dominant. Amabilis fir and Douglas-fir may be minor species.

UNDERSTORY COMPOSITION:

Shrubs: Red huckleberry (D,E), black huckleberry (D,E), Alaskan blueberry (D,E), salmonberry (E), devil's club (E)

Herbs: **Deer fern** (D,E), fern-leaved goldthread, five-leaved bramble, bunchberry (E), sword fern (D,E), three-leaved foamflower, rosy twistedstalk

Mosses: ***Hylocomium splendens, Stokesiella oreganum,*** *Rhytidiadelphus loreus, Rhytidiopsis robusta*

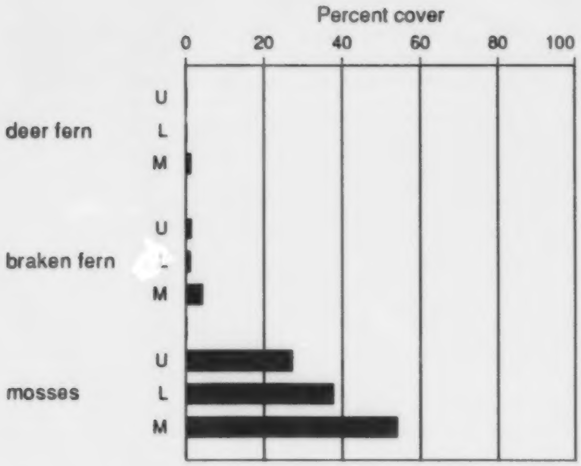
TIMBER VALUE: Primarily medium to good sites, except in the CWHd where this type has low to poor value for timber production

VALUE TO DEER: Forage potential on these moist sites is moderate-high in all seasons. Salmonberry, huckleberries, sword fern, deer fern, bunchberry, and conifer foliage provide abundant winter forage. Arboreal lichen is less abundant than on drier sites. In recent clearcuts, especially at higher elevations, fireweed quickly dominates. Young stands can soon become too dense, choking out the understory and providing deer with sites functional only as cover.

VALUE TO ELK: The Deer fern understory type is of high value to elk. Forage potential is high during all seasons of the year, but deep snow in some areas makes it unavailable during winter. The abundant deer fern attracts moderate to heavy elk use. Hemlock foliage is generally available in large quantities, along with some salmonberry, red elderberry, devil's club, bunchberry, and sword fern. During spring and summer, recent clearcuts provide the greatest abundance of forage.

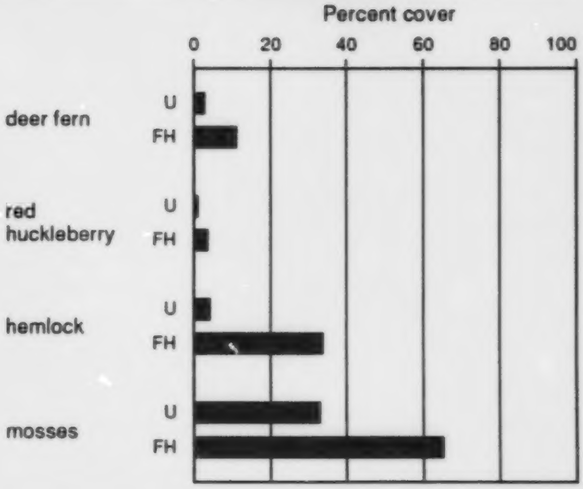
FORESTRY EFFECTS:

Commercial Thinning - Long-term understory abundance following commercial thinning seems dependent on pre- and post-treatment stand densities. Forage abundance in unthinned stands is quite low and light thinning yields minor understory increases (Figure 4). Heavier thinning in conjunction with fertilization provides substantially more forage for deer and elk (Figure 5).



Stand treatment	Tree density	Basal area
U - unthinned	1690/ha	64.2m^2/ha
L - lightly thinned	1210/ha	53.8m^2/ha
M - moderately thinned	990/ha	46.0m^2/ha

Figure 4. Abundance of selected understory species and forage types in a western hemlock stand (site class = medium) thinned 44 years after establishment and sampled 9 years later (Nyberg et al. 1990a).



Stand treatment	Tree density	Basal area
U - unthinned	985/ha	82.6m^2/ha
FH - fertilized, heavily thinned	293/ha	42.1m^2/ha

Figure 5. Abundance of selected understory species and forage types in a western hemlock stand (site class = medium) thinned 64 years after establishment and sampled 8 years later (Nyberg et al. 1990a).

HUCKLEBERRY - DULL OREGON-GRAPE

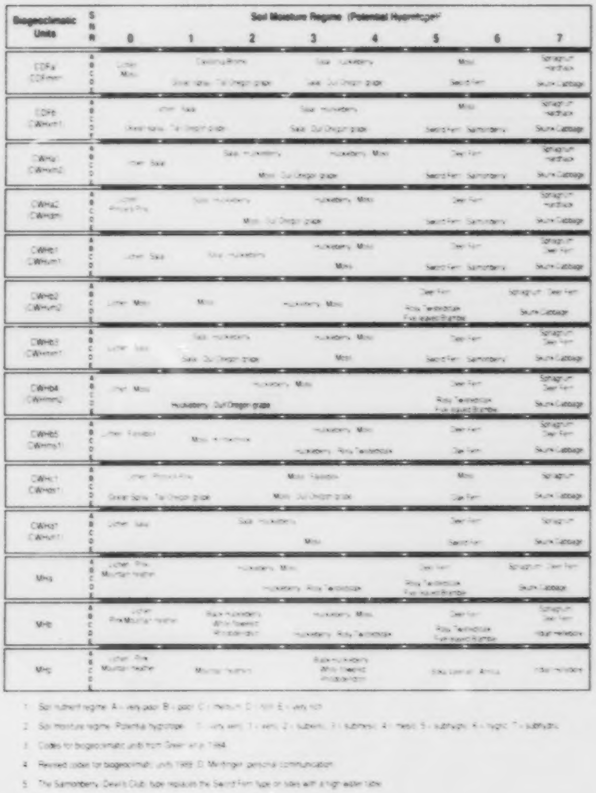


Figure 6. The position of the Huckleberry - Dull Oregon-grape understory type on the biogeoclimatic unit/edatope matrix.

Table 4. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Moderate	Moderate	Moderate
Elk	Moderate	Low	Low

LOCATION: On Vancouver Island, at higher elevations on the leeward side of the Vancouver Island Mountains

BIOGEOCLIMATIC UNITS: The Leeward Montane Maritime Wetter Coastal Western Hemlock Variant (**CWHb4**)

SITE PROPERTIES:

Soil Moisture Regime: 1-2

Soil Nutrient Regime: Medium to very rich (C-E)

Slope Position and Soil Features: Mainly on upper slopes with shallow to deep soils (morainal veneers or blankets) of fine to medium texture

STAND COMPOSITION: Mainly Douglas-fir, occasionally with western white pine

UNDERSTORY COMPOSITION:

Shrubs: **Red huckleberry** (D,E), **oval-leaved blueberry** (D,E), **dull Oregon-grape** (D,E)

Herbs: Vanilla-leaf, bunchberry (D,E)

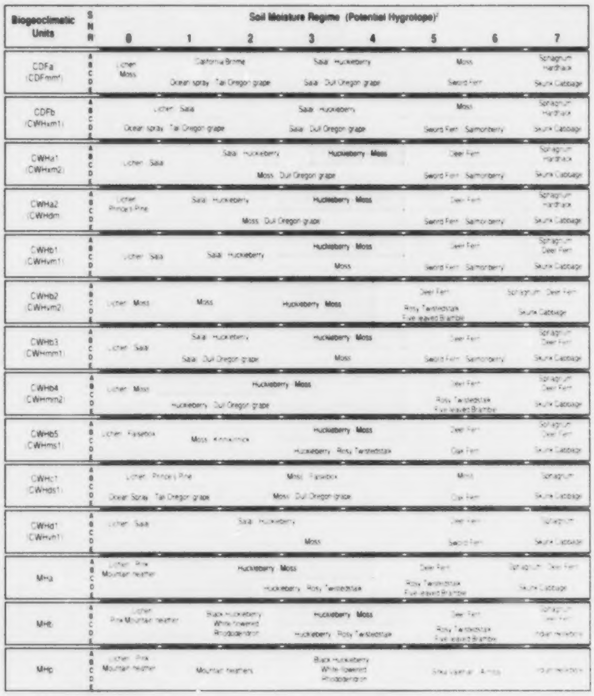
Mosses: ***Rhytidiopsis robusta***

TIMBER VALUE: Productivity of Douglas-fir is poor on these sites, mainly because of dryness and the high elevation.

VALUE TO DEER: This understory type is usually inaccessible to deer during the winter months because of deep snow. It is characterized by abundant huckleberries and dull Oregon-grape. Although these species are eaten by deer year-round, they are least preferred during spring and summer. Forage potential — and deer use — is thus low to moderate. New clearcuts can provide some preferred forage in spring and summer, but older successional stages have few pioneer species present and are not as likely to be used, except as cover.

VALUE TO ELK: Although winter forage potential is moderate, deep snow accumulations limit elk use during winter. During the growing season, however, this type may receive light use from migratory elk. This type is most useful as a source of thermal and security cover.

HUCKLEBERRY - MOSS


Biogeoclimatic Units
SNR[1]
Soil Moisture Regime (Potential Hygrotope)[2]
0
1
2
3
4
5
6
7
CDFa (CDFmm)
Lichen Moss
California Brome
Salal - Huckleberry
Moss
Sphagnum Hardhack
Ocean spray - Tall Oregon grape
Salal - Dull Oregon grape
Sword Fern
Skunk Cabbage
CDFb (CWHxm1)
Lichen - Salal
Salal - Huckleberry
Moss
Sphagnum Hardhack
Ocean spray - Tall Oregon grape
Salal - Dull Oregon grape
Sword Fern - Salmonberry
Skunk Cabbage
CWHa1 (CWHxm2)
Lichen - Salal
Salal - Huckleberry
Huckleberry - Moss
Deer Fern
Sphagnum Hardhack
Moss - Dull Oregon grape
Sword Fern - Salmonberry
Skunk Cabbage
CWHa2 (CWHdm)
Lichen Prince's Pine
Salal - Huckleberry
Huckleberry - Moss
Deer Fern
Sphagnum Hardhack
Moss - Dull Oregon grape
Sword Fern - Salmonberry
Skunk Cabbage
CWHb1 (CWHvm1)
Lichen - Salal
Salal - Huckleberry
Huckleberry - Moss
Deer Fern
Sphagnum Deer Fern
Moss
Sword Fern - Salmonberry
Skunk Cabbage
CWHb2 (CWHvm2)
Lichen - Moss
Moss
Huckleberry - Moss
Deer Fern
Sphagnum - Deer Fern
Rosy Twistedstalk Five-leaved Bramble
Skunk Cabbage
CWHb3 (CWHmm1)
Lichen - Salal
Salal - Huckleberry
Huckleberry - Moss
Deer Fern
Sphagnum Deer Fern
Salal - Dull Oregon grape
Moss
Sword Fern - Salmonberry
Skunk Cabbage
CWHb4 (CWHmm2)
Lichen - Moss
Huckleberry - Moss
Deer Fern
Sphagnum Deer Fern
Huckleberry - Dull Oregon grape
Rosy Twistedstalk Five-leaved Bramble
Skunk Cabbage
CWHb5 (CWHms1)
Lichen - Falsebox
Moss - Kinnikinnick
Huckleberry - Moss
Deer Fern
Sphagnum Deer Fern
Huckleberry - Rosy Twistedstalk
Oak Fern
Skunk Cabbage
CWHc1 (CWHds1)
Lichen - Prince's Pine
Moss - Falsebox
Moss
Sphagnum
Ocean Spray - Tall Oregon grape
Moss - Dull Oregon grape
Oak Fern
Skunk Cabbage
CWHd1 (CWHvh1)
Lichen - Salal
Salal - Huckleberry
Deer Fern
Sphagnum
Moss
Sword Fern
Skunk Cabbage
MHa
Lichen - Pink Mountain-heather
Huckleberry - Moss
Deer Fern
Sphagnum - Deer Fern
Huckleberry - Rosy Twistedstalk
Rosy Twistedstalk Five-leaved Bramble
Skunk Cabbage
MHb
Lichen Pink Mountain-heather
Black Huckleberry White-flowered Rhododendron
Huckleberry - Moss
Deer Fern
Sphagnum Deer Fern
Huckleberry - Rosy Twistedstalk
Rosy Twistedstalk Five-leaved Bramble
Indian hellebore
MHp
Lichen - Pink Mountain-heather
Mountain-heathers
Black Huckleberry White-flowered Rhododendron
Sitka Valerian - Arnica
Indian hellebore

1 Soil nutrient regime: A = very poor, B = poor, C = medium, D = rich, E = very rich

2 Soil moisture regime (Potential hygrotope): 0 = very xeric, 1 = xeric, 2 = subxeric, 3 = submesic, 4 = mesic, 5 = subhygric, 6 = hygric, 7 = subhydric

3 Codes for biogeoclimatic units from Green et al. 1984

4 Revised codes for biogeoclimatic units 1988 (D. Meidinger, personal communication)

5 The Salmonberry (Devil's Club) type replaces the Sword Fern type on sites with a high water table

Figure 7. The position of Huckleberry - Moss understory type on the biogeoclimatic unit/edatope matrix.

Table 5. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Low	High	High
Elk	Moderate	Moderate	Moderate

LOCATION: Throughout Vancouver Island and the coastal mainland

BIOGEOCLIMATIC UNITS: A wide range of Coastal Western Hemlock Variants (**CWHa1, CWHa2, CWHb1, CWHb2, CWHb3, CWHb4, CWHb5**) and Mountain Hemlock Subzones (**MHa, MHb**)

SITE PROPERTIES:

Soil Moisture Regime: Primarily **3-4**, but **1-4** in the **CWHb4** and **MHa**

Soil Nutrient Regime: Mainly very poor to medium (**A-C**), but some very poor to very rich (**A-E**)

Slope Position and Soil Features: Mainly on upper to middle slopes with shallow to deep, fine- to coarse-textured soils (morainal or colluvial blankets or veneers). May also be found on flats with coarser-textured soils.

STAND COMPOSITION: At lower elevations (CWHa1 and CWHa2) Douglas-fir and western hemlock dominate; at higher elevations (CWHb1, CWHb2, CWHb3, CWHb4) Douglas-fir disappears and amabilis fir and western hemlock dominate. In the MHa and MHb, western hemlock is replaced by mountain hemlock.

UNDERSTORY COMPOSITION:

Shrubs: **Red huckleberry** (D,E), **Alaskan blueberry** (D,E), oval-leaved blueberry (D,E), black huckleberry (D,E), false azalea, salal (D), trailing blackberry (D)

Herbs: Deer fern (D,E), five-leaved bramble, rattlesnake-plantain, bunchberry (D,E), rosy twisted-stalk, fern-leaved goldthread, heart-leaved twayblade, twinflower (E), sword fern (D,E), three-leaved foamflower

Mosses: ***Stokesiella oreganum,*** *Hylocomium splendens, Rhytidiadelphus loreus, Rhytidiopsis robusta*

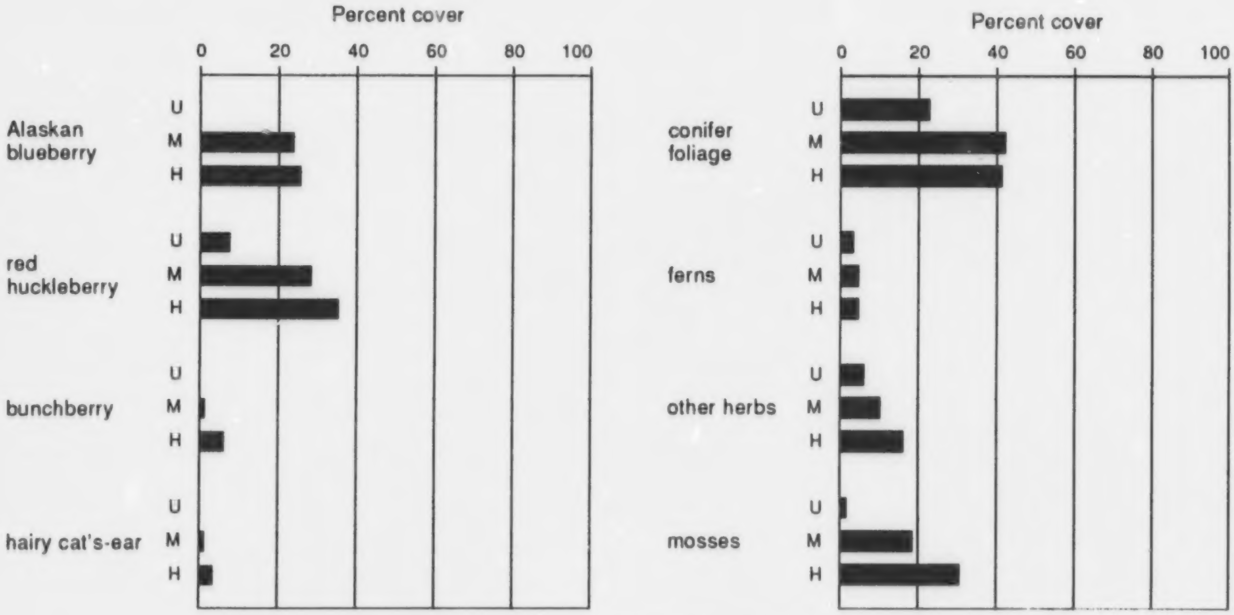
TIMBER VALUE: In the CWHa subzone, Douglas-fir is the preferred species, producing poorly to moderately. In the CWHb, western hemlock may be the preferred alternative, depending on site characteristics. Sites in the CWHb tend to moderate timber production.

VALUE TO DEER: The greatest value of the Huckleberry - Moss type is at high elevations, where from spring through fall it provides abundant preferred forage. Recent clearcuts produce numerous ferns (bracken especially) and forbs; later successional stages are dominated by huckleberries. Only the very dense seral stages provide little food. Where it occurs at lower elevations, this type receives light use year-round.

VALUE TO ELK: This understory type is common just upslope from more valuable types. Forage diversity is much greater than that of drier sites, although understory abundance can be poor on low-elevation sites. Preferred forage species such as deer fern, twinflower, and bunchberry, plentiful in some Huckleberry - Moss habitats, provide moderate spring and summer-fall forage. Deep snow in the montane subzones sometimes prevents winter use there.

FORESTRY EFFECTS:

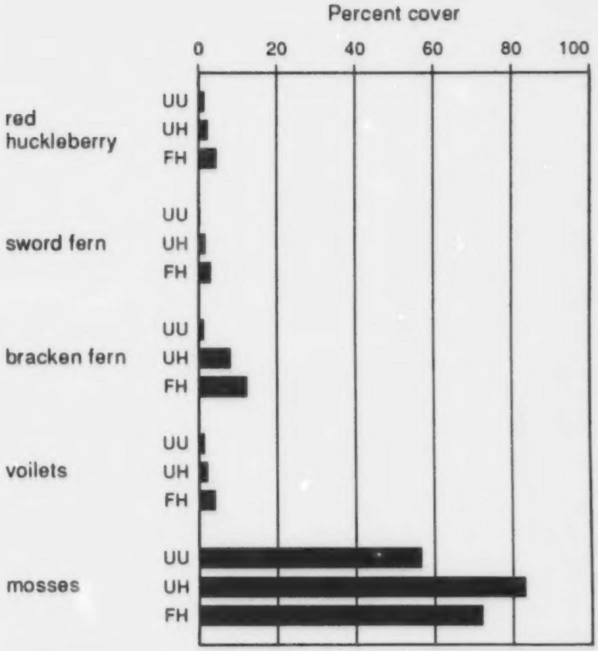
Non-Commercial Thinning: Typically, non-commercial thinning in the Huckleberry - Moss understory type maintains good diversity and abundance of deer and elk forage. In one trial, huckleberries, herbs, mosses, and conifer foliage were all more abundant on thinned plots than on controls (Figure 8). A stand that was thinned moderately 18+ years after establishment showed smaller but significant increases in red huckleberry, salal, vanilla leaf, and mosses (Nyberg *et al.* 1990a).



Stand treatment	Tree density	Basal area
U - unthinned	10670/ha	46.0m²/ha
M - moderately thinned	920/ha	13.1m²/ha
H - heavily thinned	580/ha	8.2m²/ha

Figure 8. Abundance of selected understory species and forage types in a Douglas-fir stand (site class = poor) thinned 16 years after establishment and sampled 8 years later (Nyberg et al. *1990a).*

Commercial Thinning: A study of plots in a Douglas-fir thinning trial in the CWHa1 variant showed increases in all understory groups following thinning, even though plant abundance was low (Figure 9). Fertilizer application after thinning yielded an additional increase in understory. At a second site, where understory abundance was even lower, thinning caused little or no change in abundance (Nyberg *et al.* 1990a). This may have been a result of higher stand density before thinning.



Stand treatment	Tree density	Basal area
UU - unfertilized, unthinned	1046 / ha	62.8m^2 / ha
UH - unfertilized, heavily thinned	411 / ha	37.4m^2 / ha
FH - fertilized, heavily thinned	478 / ha	39.1m^2 / ha

Figure 9. Abundance of selected understory species and forage types in a Douglas-fir - western hemlock stand (site class = medium) thinned 44 years after planting and sampled 7 years later (Nyberg et al. *1990a).*

HUCKLEBERRY - ROSY TWISTEDSTALK

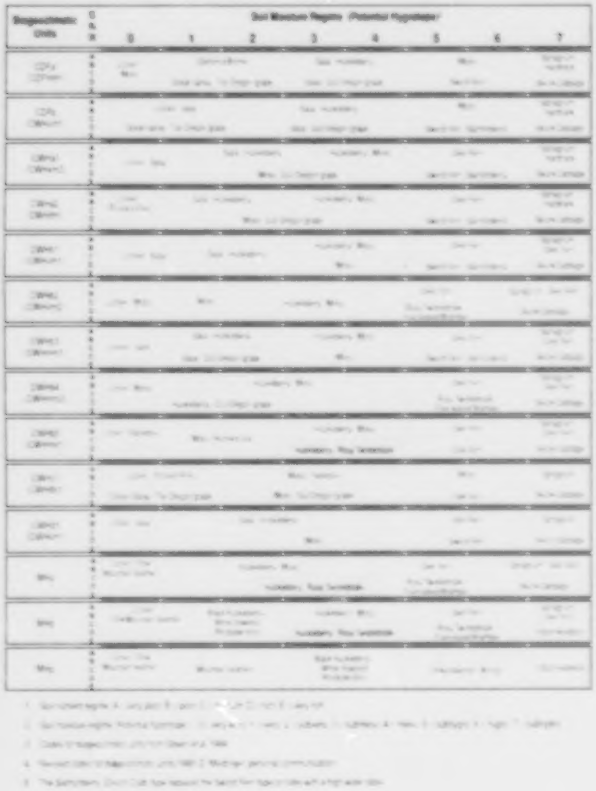


Figure 10. The position of the Huckleberry - Rosy twistedstalk understory type on the biogeoclimatic unit/edatope matrix.

Table 6. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Moderate	High	High
Elk	Low	Moderate	Moderate

LOCATION: On Vancouver Island and the coastal mainland

BIOGEOCLIMATIC UNITS: The Southern Submaritime Variant of the Wetter Coastal Western Hemlock Subzone (**CWHb5**) and the Forested Mountain Hemlock Subzones (MHa, MHb)

SITE PROPERTIES:

Soil Moisture Regime: **3-4** in the **CWHb5** and **2-4** in the **MH**

Soil Nutrient Regime: Medium to very rich (C-E)

Slope Position and Soil Features: Mainly on middle slopes with deep, medium- to fine-textured soils (morainal blankets)

STAND COMPOSITION: Douglas-fir is dominant in the CWHb5; mountain hemlock and amabilis fir are dominant in the MHa. In the MHb, mountain hemlock may be replaced by Engelmann spruce.

UNDERSTORY COMPOSITION:

Shrubs: **Alaskan blueberry** (D,E), **oval-leaved blueberry** (D,E), **black huckleberry** (D,E)

Herbs: **Rosy twistedstalk, five-leaved bramble,** mountain holly fern, star-flowered false Solomon's-seal

Mosses: ***Rhytidiopsis robusta***

TIMBER VALUE: These are medium sites except in the MHa, where they can also be poor.

VALUE TO DEER: Spring and summer forage potential is high. Forage is particularly abundant in early seral stages. In recent clearcuts, fireweed usually invades and provides plentiful forage. Depending on elevation and aspect, herb development may be seasonally delayed so that high-quality food is available until mid-autumn. Huckleberries and numerous herbs provide good winter forage in open older stands.

VALUE TO ELK: This type is of potential value to elk where recent clearcuts produce lush herbs for spring and summer. Migratory elk may find the mature seral stages suitable for cover; forage production within such stands is light to moderate but only a few of the available plants are preferred elk foods.

INDIAN HELLEBORE

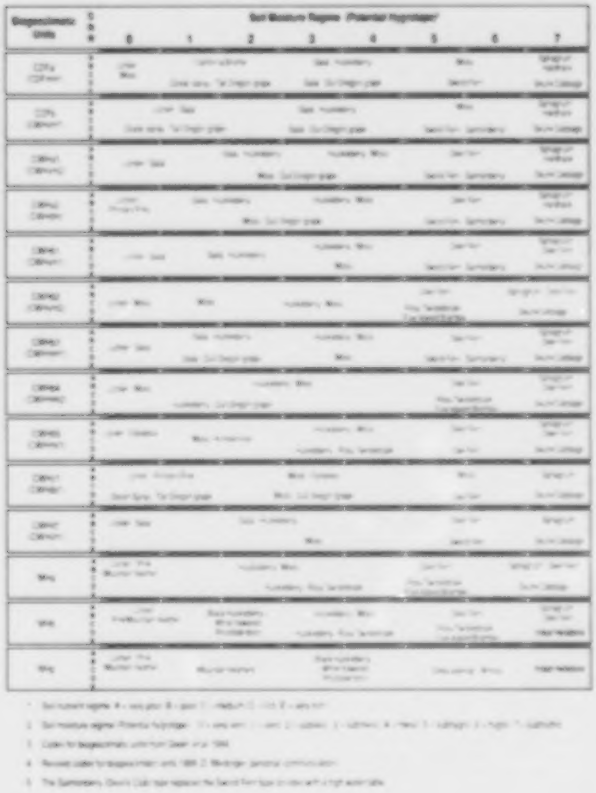


Figure 11. The position of the Indian hellebore understory type on the biogeoclimatic unit/edatope matrix.

Table 7. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	**Spring**	**Summer**
Deer	Low	Moderate	Moderate
Elk	Low	Low	Low

LOCATION: On Vancouver Island and the coastal mainland, in mountainous areas at high elevations

BIOGEOCLIMATIC UNITS: Two of the three Mountain Hemlock Subzones (MHb, MHp)

SITE PROPERTIES:

Soil Moisture Regime: 7

Soil Nutrient Regime: Medium to very rich (C-E)

Slope Position and Soil Features: Mainly in depressions and flats with organic soils (organic veneers or blankets) or fine-textured soils (fluvial or lacustrine materials), and the water table within 30 cm of the surface or abundant seepage close to the surface

STAND COMPOSITION: Mainly yellow-cedar, Engelmann spruce, amabilis fir, and subalpine fir with a very open canopy. In the MHp, tree growth is clumped and poor.

UNDERSTORY COMPOSITION:

Herbs: **Indian hellebore,** white bog-orchid, wood horsetail, marsh-marigold, sedges (D,E), grass-of-Parnassus

TIMBER VALUE AND MANAGEMENT: Negligible timber production

VALUE TO DEER: Following green-up, which can be delayed by deep snow, the Indian hellebore type is a productive and preferred habitat of migratory black-tailed deer. Moderate to heavy use occurs in late spring through summer.

VALUE TO ELK: The Indian hellebore understory type is used by elk during late spring and summer at high elevations where it occurs adjacent to vegetated slides. Spring and summer forage potential is relatively low.

LICHEN - FALSEBOX

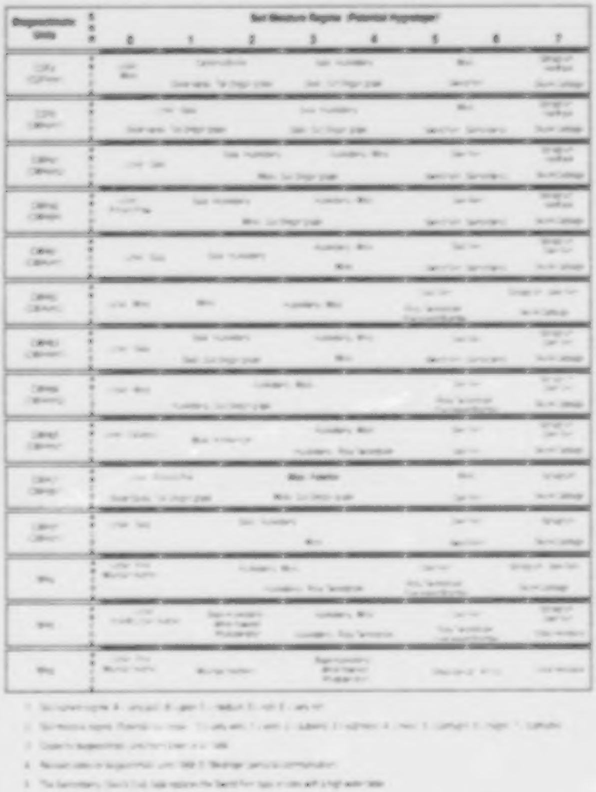


Figure 12. The position of the Lichen - Falsebox understory type on the biogeoclimatic unit/edatope matrix.

Table 8. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Moderate	Low	Low
Elk	Low	Low	Low

LOCATION: On the mainland in the transitional (submaritime) area between maritime and continental climatic zones

BIOGEOCLIMATIC UNITS: The Southern Submaritime Wetter Variant of the Coastal Western Hemlock Zone (CWHb5)

SITE PROPERTIES:

Soil Moisture Regime: 0

Soil Nutrient Regime: Primarily very poor to medium (A-C)

Slope Position and Soil Features: Mainly on ridge crests and upper slopes with shallow, coarse-textured soils (morainal or colluvial veneers over bedrock), sometimes adjacent to rock outcrops

STAND COMPOSITION: Mainly lodgepole pine

UNDERSTORY COMPOSITION:

Shrubs: **Falsebox** (D), kinnikinnick (D)

Herbs: Grasses (D,E)

Mosses and Lichens: *Pleurozium schreberi*, *Peltigera aphthosa*, **lichens** (D)

TIMBER VALUE: Marginal timber production; very slow-growing trees because of dry sites

VALUE TO DEER: Depending on elevation, this type may be inaccessible during the winter as a result of deep snowpacks. Forage potential is greatest during winter because of the shrub-dominated understory and arboreal lichens. Overall forage abundance is relatively low, but the species present are valuable winter foods. The presence of rock outcrops in or adjacent to this type increases its value in winter. Mature and older stands are of greatest value. During spring, some forbs and grasses will be present, but deer use is still likely to be low.

VALUE TO ELK: Elk are scarce or absent on the mainland where this type occurs. It is unlikely to receive more than minimal use because it has a very low forage potential for elk and would be unavailable during winters with deep snow.

LICHEN - MOSS

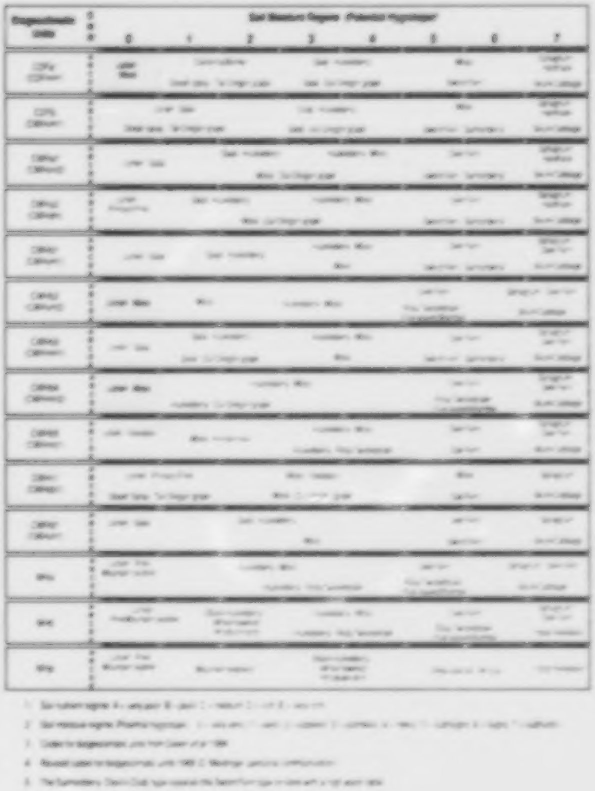


Figure 13. The position of the Lichen - Moss understory type on the biogeoclimatic unit/edatope matrix.

Table 9. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Low	Low	Low
Elk	Low	Low	Low

LOCATION: On southeastern Vancouver Island and the Gulf Islands, and at high elevations in the Vancouver Island Mountains where winters are severe and snow is deep

BIOGEOCLIMATIC UNITS: The Drier Maritime Coastal Douglas-fir (**CDFa**) Subzone, and Windward and Leeward Montane Maritime Wetter Variants of the Coastal Western Hemlock Zone (**CWHb2, CWHb4**)

SITE PROPERTIES:

Soil Moisture Regime: **0**

Soil Nutrient Regime: Primarily very poor to medium (**A-C**)

Slope Position and Soil Features: Mainly ridge crests and upper slopes with shallow, coarse-textured soils (morainal or colluvial veneers over bedrock), sometimes adjacent to rock outcrops

STAND COMPOSITION: Mainly lodgepole pine with some Douglas-fir

UNDERSTORY COMPOSITION:

Shrubs: Western tea-berry

Herbs: Grasses (D,E)

Mosses and Lichens: ***Pleurozium schreberi***, ***Rhytidiopsis robusta*****, terrestrial lichens**

TIMBER VALUE: Negligible timber production

VALUE TO DEER: At high elevations this understory type is subject to deep winter snowfall and, in most years, is available to deer only from late spring through fall. Understory forage is limited to minor amounts of low shrubs and herbs. Migratory deer use this fairly open type for bedding sites more than for foraging. Logging such habitats will provide little or no forage benefit and is unlikely to cause major change in deer use.

VALUE TO ELK: At high elevations this type is usually inaccessible to elk during the winter months. The exceptionally low winter forage potential makes it unlikely that such sites would be used even during snow-free winters. In the summer and fall, migratory elk frequenting the montane subzones in which this dry habitat occurs do not use the type because it lacks the abundant, lush forage that is available in habitats on lower slopes.

LICHEN - PINK MOUNTAIN-HEATHER

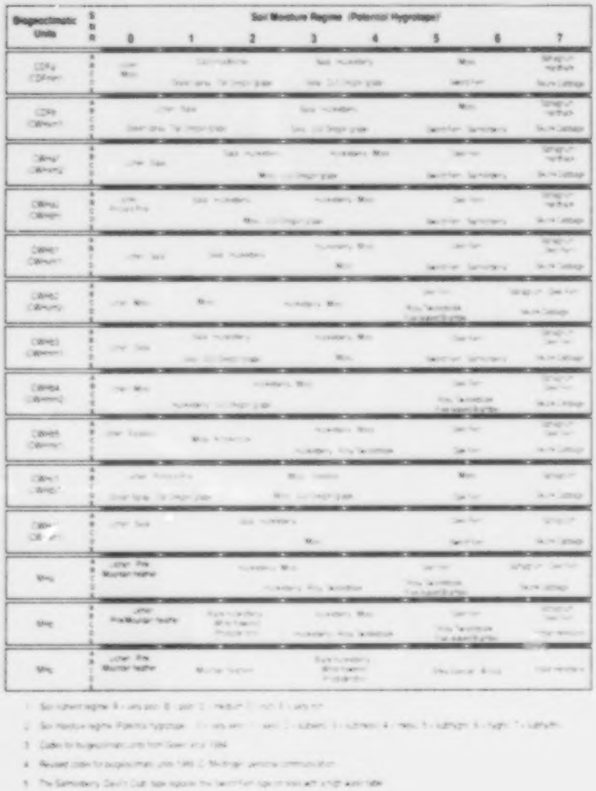


Figure 14. The position of the Lichen - Pink mountain-heather understory type on the biogeoclimatic unit/edatope matrix.

Table 10. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	**Spring**	**Summer**
Deer	Low	Low	Low
Elk	Low	Low	Low

LOCATION: On Vancouver Island and the coastal mainland, in mountainous areas at high elevations

BIOGEOCLIMATIC UNITS: The Mountain Hemlock Zone (**MHa, MHb, MHp**)

SITE PROPERTIES:

Soil Moisture Regime: **Primarily 0**

Soil Nutrient Regime: Primarily very poor to medium (**A**-C)

Slope Position and Soil Features: Mainly on ridge crests and upper slopes with shallow, coarse-textured soils (colluvial or morainal veneer over bedrock)

STAND COMPOSITION: Mainly mountain hemlock with very minor amounts of yellow-cedar

UNDERSTORY COMPOSITION:

Shrubs: **Pink mountain-heather, white mountain-heather,** black huckleberry, western tea-berry

Herbs: Grasses (D,E)

Mosses and Lichens: *Rhacomitrium heterostichum,* **lichens**

TIMBER VALUE: Negligible timber production

VALUE TO DEER: Because this understory type occurs only in Mountain Hemlock subzones, deep snow accumulations preclude deer use from late fall through late spring in most years. Forage potential is low. Deer use the area most during summer and fall because cool weather delays plant development. All seral stages are likely to be used, but early seral stages will provide the most forage.

VALUE TO ELK: Elk eat few of the plants that grow in this type, so forage potential is very low in all seasons. Migratory elk using montane habitats will probably not use this understory type, regardless of seral stage.

LICHEN - PRINCE'S PINE

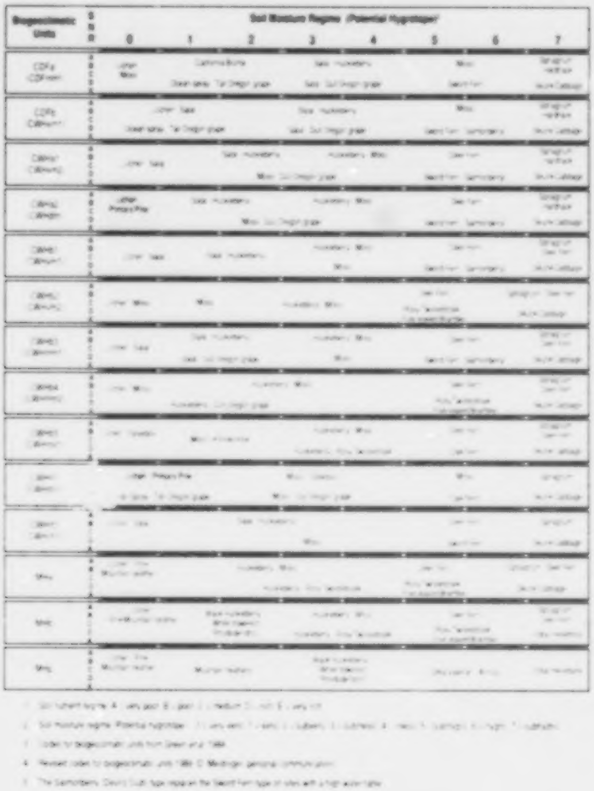


Figure 15. The position of the Lichen - Prince's pine understory type on the biogeoclimatic unit/ edatope matrix.

Table 11. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Moderate	Low	Low
Elk	Low	Low	Low

LOCATION: In coastal areas of the mainland and in the transitional area between the maritime and the interior climates of B.C.

BIOGEOCLIMATIC UNITS: Drier portions of the Coastal Western Hemlock Zone (**CWHa2 and CWHc1**)

SITE PROPERTIES:

Soil Moisture Regime: **0-1**

Soil Nutrient Regime: Primarily very poor to medium (**A-C**), but occurs on rich sites in the CWHa2 variant

Slope Position and Soil Features: Mainly on ridge crests and upper slopes with coarse-textured, shallow soils (morainal or colluvial veneers over bedrock), often associated with rock outcrops

STAND COMPOSITION: Mainly lodgepole pine with a minor component of Douglas-fir

UNDERSTORY COMPOSITION:

Shrubs: **Prince's pine,** kinnikinnick (D), common juniper, saskatoon (D)

Herbs: Grasses (D,E), spreading dogbane

Mosses and Lichens: ***Pleurozium schreberi, Rhacomitrium canescens,*** *Hylocomium splendens,* **lichens** (d)

TIMBER VALUE: This type has marginal timber production because of very dry conditions

VALUE TO DEER: This dry type is similar to the Lichen - Salal understory type, except in forage potential. The lack of understory greatly reduces its value to deer; only saskatoon and arboreal lichens (in older seral stages) are important. Because of the lichens and the favourable thermal conditions on some south-facing aspects, deer may use this type in winter. Reduced snow depths on exposed areas could make grass and shrubs available to supplement the lichens and conifer forage.

VALUE TO ELK: Currently no Roosevelt elk are present in the coastal area where this understory type is found, other than a small group transplanted to the Sechelt Peninsula. Because forage is limited, it seems likely that elk would make little use of this type.

LICHEN - SALAL

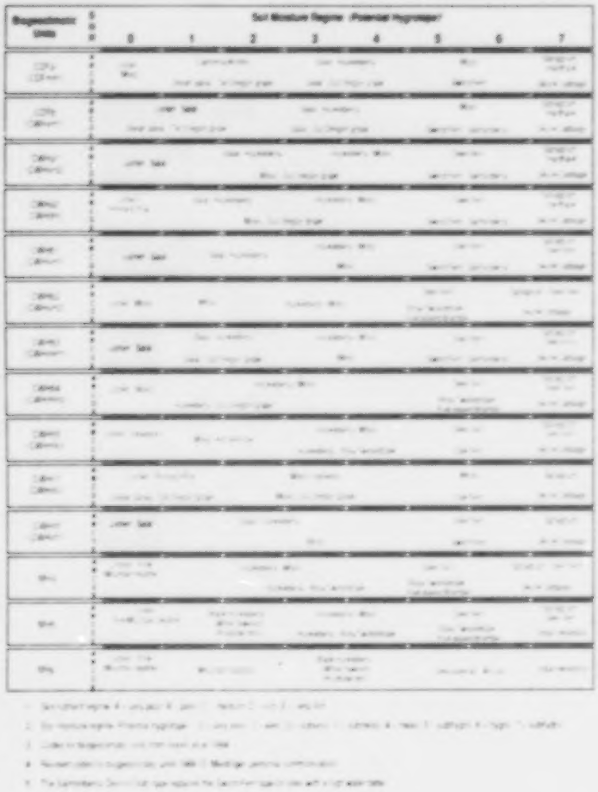


Figure 16. The position of the Lichen - Salal understory type on the biogeoclimatic unit/edatope matrix.

Table 12. Potential forage values, by season, for deer and elk

Species	**Season**		
	Winter	**Spring**	**Summer**
Deer	Moderate	Low	Low
Elk	Low	Low	Low

LOCATION: On Vancouver Island

BIOGEOCLIMATIC UNITS: The Wetter Maritime Coastal Douglas-fir (**CDFb**) Subzone, and Coastal Western Hemlock Variants **CWHa1, CWHb1, CWHb3,** and **CWHd**

SITE PROPERTIES:

Soil Moisture Regime: 0-1 except in the CDF

Soil Nutrient Regime: Very poor to rich (A-D) except in the CDF where it is found only on very poor to medium (A-C) sites

Slope Position and Soil Features: Mainly on ridge crests and upper slopes with coarse-textured soils (morainal or colluvial veneers over bedrock), often adjacent to rock outcrops

STAND COMPOSITION: Mainly Douglas-fir and lodgepole pine, with minor amounts of western redcedar and western hemlock

UNDERSTORY COMPOSITION:

Shrubs: **Salal** (D,E), red huckleberry (D,E)

Herbs: Grasses (D,E)

Mosses and Lichens: ***Rhacomitrium canescens, lichens*** (D)

TIMBER VALUE: This type is marginal for timber production because of very dry site conditions.

VALUE TO DEER: This type is likely to receive low to moderate use year-round, in all successional stages. Forage potential is relatively low, except in winter. Arboreal lichens are often found on the slow-growing trees and, together with salal and huckleberries, provide preferred winter forage. In the spring, a shortage of herbs limits the forage potential, although sprouting grasses provide some food. During fall, when deer diets include more shrubs, this type is more attractive to deer. The poor tree growth and proximity to rock outcrops provide openings in which animals can exploit the thermal benefits of winter sunshine. They may use this type as thermal cover at night during the winter, or as security cover on adjacent rock outcrops.

VALUE TO ELK: Because of a lack of preferred forage, these dry sites are infrequently used by Roosevelt elk. As with deer, use is likely to be greatest when snow is deep and elk are using adjacent rock outcrops during the day. During mild winters, use of rock outcrops and this understory type is minimal.

MOSS

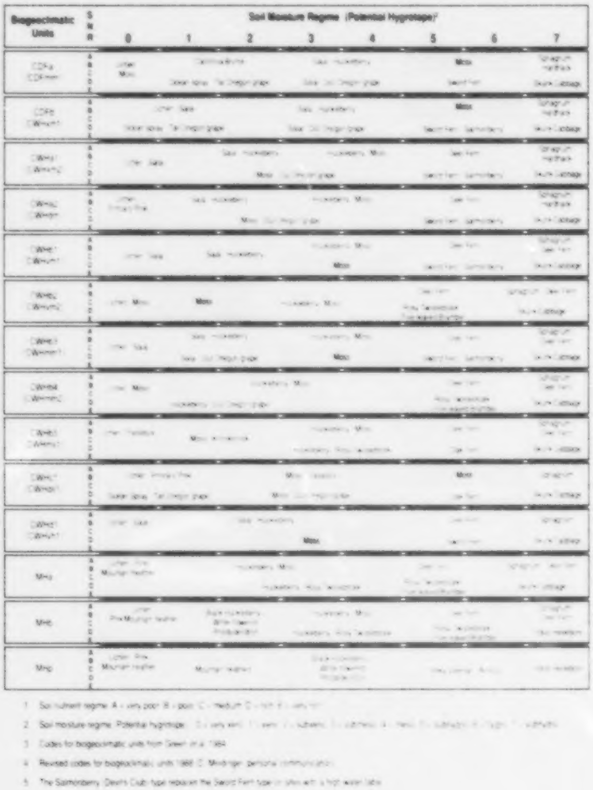


Figure 17. The position of the Moss understory type on the biogeoclimatic unit/edatope matrix.

Table 13. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Low	Low	Low
Elk	Low	Low	Low

LOCATION: On Vancouver Island

BIOGEOCLIMATIC UNITS: The Coastal Douglas-fir Zone (CDF) and some wet Coastal Western Hemlock units (CWHb1, CWHb2, CWHb3, CWHd)

SITE PROPERTIES:

Soil Moisture Regime: 1-6

Soil Nutrient Regime: A wide range (A-E) depending on the biogeoclimatic unit

Slope Position and Soil Features: In the CWHb1 on middle slopes with deep, coarse- to fine-textured soils; in the CWHb2 on upper slopes with shallow to moderately deep, coarse-textured soils; and in the CDF on lower slopes and flats with deep, coarse-textured soils

STAND COMPOSITION: In the CDF, Douglas-fir is dominant, with some western redcedar present; in the CWHb, western hemlock may replace Douglas-fir.

UNDERSTORY COMPOSITION:

Shrubs: Oval-leaved blueberry (D,E), salal (D,E)

Herbs: Sword fern (D,E), spiny wood fern, bracken (D), single delight, bunchberry (E)

Mosses: ***Stokesiella oreganum, Rhytidiadelphus loreus, Rhytidiopsis robusta, Hylocomium splendens***

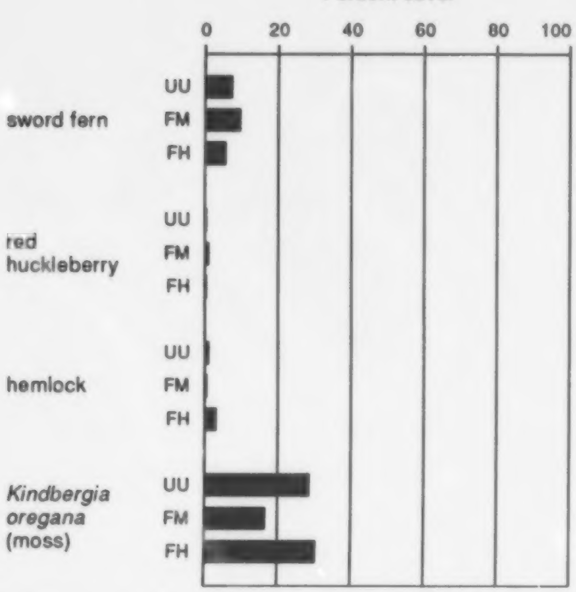
TIMBER VALUE: Medium to good sites for timber production, except in the CWHb2 where sites tend to be poor

VALUE TO DEER: This habitat lacks most understory forage, so its potential is low. Burning to remove logging debris can improve forage, primarily because of the resulting invasion by fireweed and other pioneers.

VALUE TO ELK: The sparse forage is inadequate to support many elk, but the Moss type usually occurs just upslope from understory types of higher value, and may serve as security and thermal cover.

FORESTRY EFFECTS:

Commercial Thinning: Because understory abundance is so limited in stands old enough for commercial thinning, even major reductions in stand density yield only small changes in forage abundance. Long-term forage increases were not apparent in commercially thinned blocks that had been fertilized at the time of thinning (Figure 18) (Nyberg *et al.* 1990a).



Stand treatment	Tree density	Basal area
UU - unfertilized, unthinned	1208/ha	83.0m²/ha
FM - fertilized, moderately thinned	757/ha	65.8m²/ha
FH - fertilized, heavily thinned	586/ha	60.3m²/ha

Figure 18. Abundance of selected understory species and forage types in a western hemlock - Douglas-fir stand (site class = medium) thinned 53 years after establishment and sampled 12 years later (Nyberg et al. *1990a).*

MOSS - DULL OREGON-GRAPE

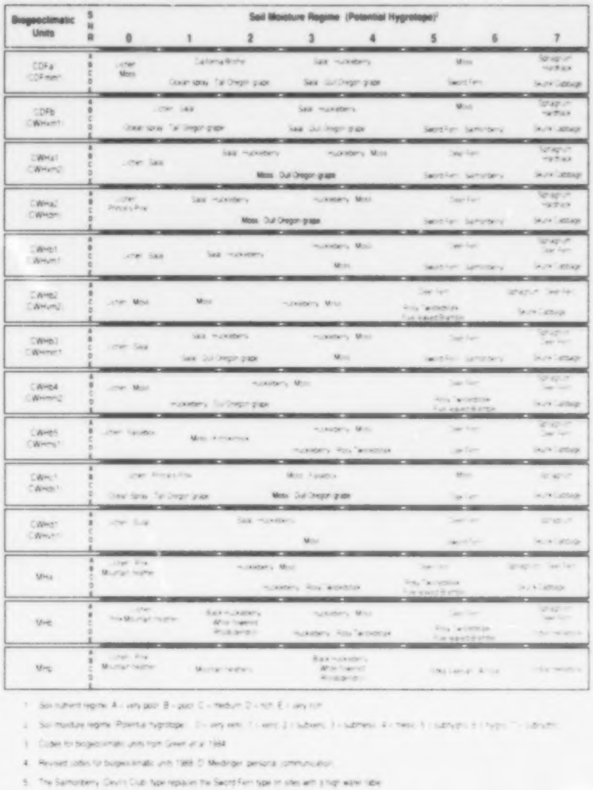


Figure 19. The position of the Moss - Dull Oregon-grape understory type on the biogeoclimatic unit/ edatope matrix.

Table 14. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Low	Moderate	Moderate
Elk	Low	Low	Low

LOCATION: On Vancouver Island and the coastal mainland

BIOGEOCLIMATIC UNITS: The drier Coastal Western Hemlock Variants (**CWHal, CWHa2, CWHc1**)

SITE PROPERTIES:

Soil Moisture Regime: 1-4

Soil Nutrient Regime: Medium to very rich (C-E)

Slope Position and Soil Features: Mainly on upper to middle slopes with deep, medium- to fine-textured soils (morainal blankets, glacio-fluvial materials)

STAND COMPOSITION: Predominantly Douglas-fir, with some western hemlock and western redcedar

UNDERSTORY COMPOSITION:

Shrubs: **Dull Oregon-grape** (D,E), trailing snowberry, ocean-spray, vine maple (D), salal (D)

Herbs: Sword fern (D,E), bracken (D), one-leaved foamflower, three-leaved foamflower, twinflower (E), vanilla-leaf

Mosses: ***Stokesiella oreganum, Rhytidiadelphus triquetrus, Hylocomium splendens***

TIMBER VALUE: The drier (1-2) sites are poor; the moister (3-4) sites are moderate timber producers.

VALUE TO DEER: Forage potential is low to moderate. Winter forage, in particular, is limited, consisting only of conifers, vine maple, and arboreal lichens in older seral stages. Early seral stages are frequently dominated by bracken, which is eaten primarily when it first emerges.

VALUE TO ELK: Several preferred elk forage species are found in this type, but their abundance is fairly low, resulting in low forage potential and minimal elk use. Use is highest in winter, primarily because this type often provides cover adjacent to more frequently used habitats.

MOSS - FALSEBOX

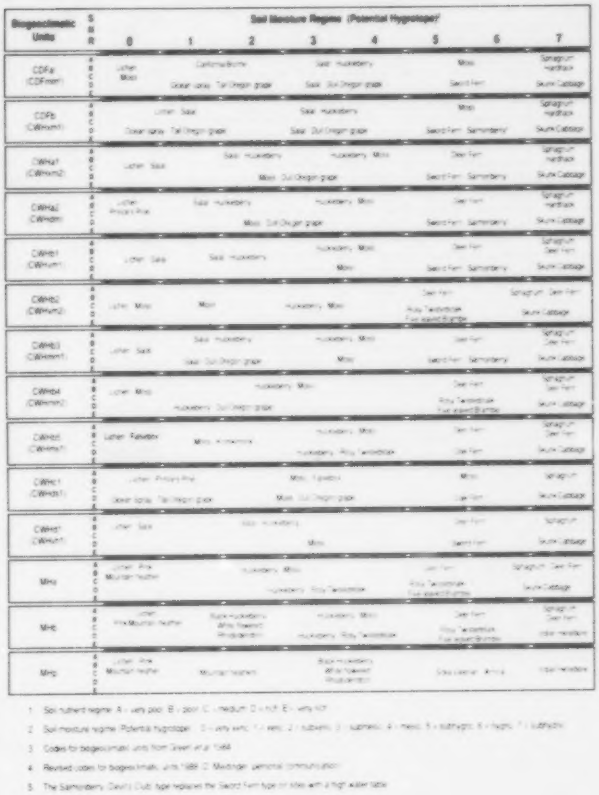


Figure 20. The position of the Moss - Falsebox understory type on the biogeoclimatic unit/edatope matrix.

Table 15. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Low	Low	Low
Elk	Low	Low	Low

LOCATION: On the coastal mainland

BIOGEOCLIMATIC UNITS: The Southern Drier Submaritime Coastal Western Hemlock Variant (CWHc1)

SITE PROPERTIES:

Soil Moisture Regime: 2-4

Soil Nutrient Regime: Very poor to medium (A-C)

Slope Position and Soil Features: Mainly on upper to middle slopes, with deep, coarse- to medium-textured soils (morainal blankets, morainal or colluvial veneers)

STAND COMPOSITION: Mainly Douglas-fir, with some western redcedar and western hemlock

UNDERSTORY COMPOSITION:

Shrubs: **Falsebox** (D), Prince's pine

Herbs: Grasses (D,E)

Mosses: ***Hylocomium splendens, Rhytidiadelphus triquetrus***

TIMBER VALUE AND MANAGEMENT: Poor to medium sites for Douglas-fir

VALUE TO DEER: Although forage potential is low in all seasons, older seral stages on south-facing slopes may support small groups of overwintering deer. Rock outcrop inclusions in this type raise its value to deer. Recent clearcuts produce greater forb and grass cover for the first few years, thus encouraging some deer use during spring and summer.

VALUE TO ELK: Forage values are very low for elk, especially during the winter.

MOSS - KINNIKINNICK

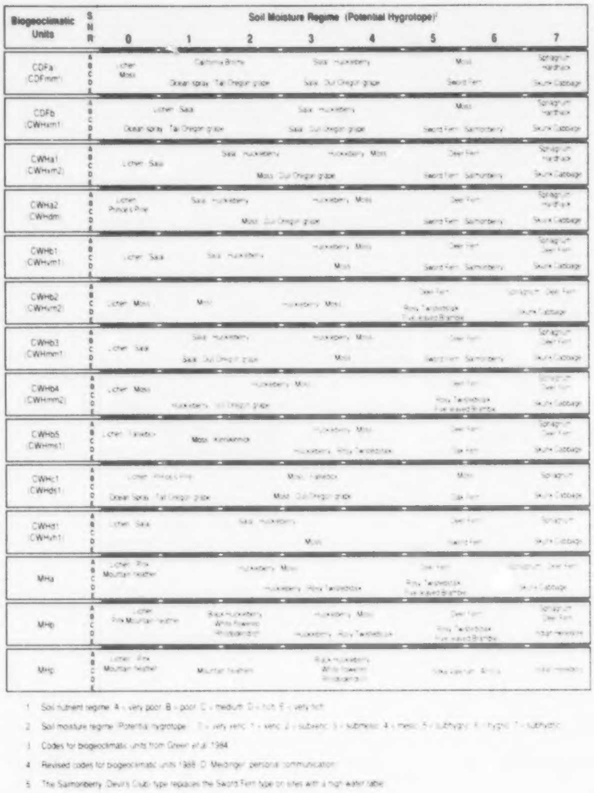

Biogeoclimatic Units
Soil Moisture Regime (Potential Hygrotope)
0
1
2
3
4
5
6
7
CDFa (CDFmm)
CDFb (CWHxm1)
CWHa1 (CWHxm2)
CWHa2 (CWHdm)
CWHb1 (CWHvm1)
CWHb2 (CWHvm2)
CWHb3 (CWHmm1)
CWHb4 (CWHmm2)
CWHb5 (CWHms1)
CWHc1 (CWHds1)
CWHd1 (CWHvh1)
MHa
MHb
MHc

Figure 21. The position of the Moss - Kinnikinnick understory type on the biogeoclimatic unit/ edatope matrix.

Table 16. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Low	Low	Low
Elk	Low	Low	Low

LOCATION: On the coastal mainland

BIOGEOCLIMATIC UNITS: The Southern Submaritime Wetter Coastal Western Hemlock Variant (**CWHb5**)

SITE PROPERTIES:

Soil Moisture Regime: **1-2**

Soil Nutrient Regime: Very poor to very rich (**A-E**)

Slope Position and Soil Features: Mainly on upper slopes, with shallow to deep, coarse- to fine-textured soils (morainal blankets, morainal or colluvial veneers)

STAND COMPOSITION: Mainly Douglas-fir

UNDERSTORY COMPOSITION:

Shrubs: **Kinnikinnick** (D), oval-leaved blueberry (D,E), Prince's pine

Herbs: Star-flowered false Solomon's-seal, grasses (D,E), hairy cat's-ear (D)

Mosses: ***Pleurozium schreberi, Hylocomium splendens, Rhytidiadelphus triquetrus***

TIMBER VALUE: Because of the dryness of these sites, timber production tends to be poor.

VALUE TO DEER: Many sites where this type occurs receive large amounts of snow and may be inaccessible during winter months. Forage potential is fairly low. During winter, arboreal lichens, Douglas-fir, and western redcedar foliage, plus some kinnikinnick and huckleberry, are often available. Dryness prevents production of high-quality spring and summer forages, even in early seral stages.

VALUE TO ELK: Forage potential is low. Older seral stages are most valuable because they can least be used as cover.

MOUNTAIN-HEATHERS

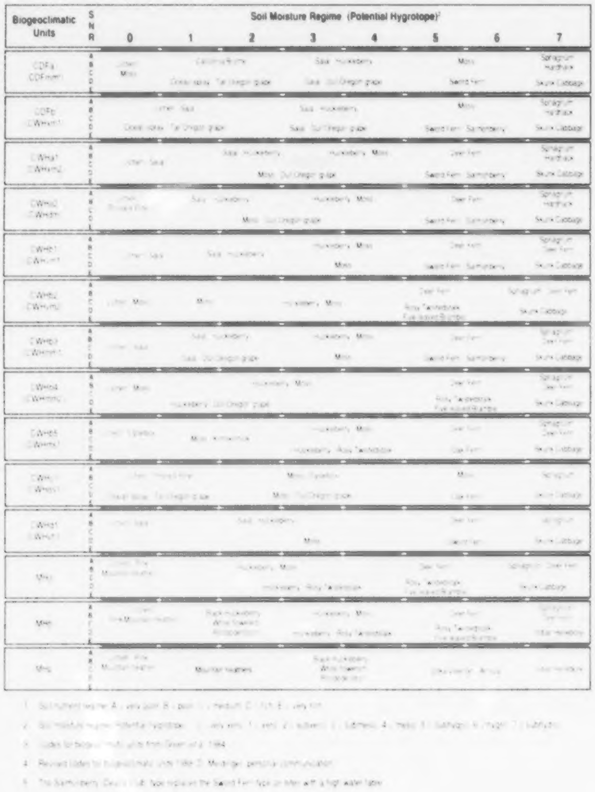


Figure 22. The position of the Mountain-heathers understory type on the biogeoclimatic unit/edatope matrix.

Table 17. Potential forage values, by season, for deer and elk

Species	**Season**		
	Winter	**Spring**	**Summer**
Deer	Low	Low	Low
Elk	Low	Low	Low

LOCATION: In the mountains of Vancouver Island and the coastal mainland at high elevations

BIOGEOCLIMATIC UNITS: The Mountain Hemlock Parkland Subzone (**MHp**)

SITE PROPERTIES:

Soil Moisture Regime: **1-2**

Soil Nutrient Regime: Very poor to very rich (**A-E**)

Slope Position and Soil Features: Mainly on upper slopes, with shallow to moderately deep, coarse-textured soils (morainal or colluvial veneers)

STAND COMPOSITION: Clumpy stands of mountain hemlock with some amabilis fir and subalpine fir

UNDERSTORY COMPOSITION:

Shrubs: **Pink mountain-heather, white mountain-heather,** partridgefoot

Herbs: Alpine anemone, sedges (E)

Lichens: Terrestrial lichens

TIMBER VALUE: Negligible timber production

VALUE TO DEER: Because of the high elevation of the MHp subzone, this type can only be used by deer during snow-free periods. The dominant vegetation, mountain-heathers and other low-growing shrubs, is of little value to deer. Only a few herbs provide preferred summer food. Potential forage values are correspondingly low. Deer use is light.

VALUE TO ELK: Elk use is very light; this type provides very little palatable forage and is at elevations above those normally used even by migratory elk. As a result, the forage potential is very low.

OAK FERN

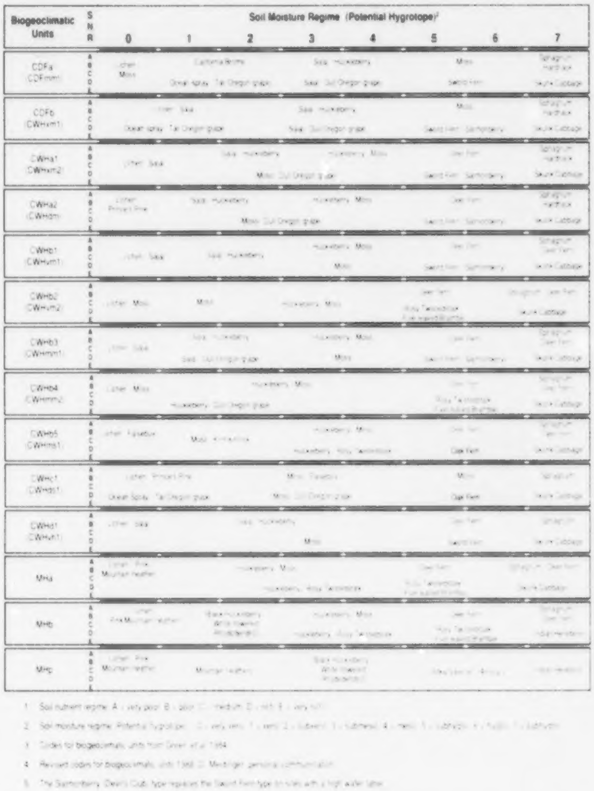

Biogeoclimatic Units
S N R
Soil Moisture Regime (Potential Hygrotope)
0
1
2
3
4
5
6
7
CDFa (CDFmm)
CDFb (CWHxm1)
CWHa1 (CWHxm2)
CWHa2 (CWHdm)
CWHb1 (CWHvm1)
CWHb2 (CWHvm2)
CWHb3 (CWHmm1)
CWHb4 (CWHmm2)
CWHb5 (CWHms1)
CWHc1 (CWHds1)
CWHd1 (CWHvh1)
MHa
MHb
MHc

Figure 23. The position of the Oak fern understory type on the biogeoclimatic unit/edatope matrix.

Table 18. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Low	Moderate	Moderate
Elk	Low	Low	Low

LOCATION: Areas on the coastal mainland that are influenced by the continental climate

BIOGEOCLIMATIC UNITS: The Southern Submaritime Wetter (**CWHb5**) and the Southern Drier Submaritime (**CWHcl**) Variants of the Coastal Western Hemlock Zone

SITE PROPERTIES:

Soil Moisture Regime: **5-6**

Soil Nutrient Regime: Medium to very rich (C-E)

Slope Position and Soil Features: Mainly on lower slopes and flats receiving moisture, with deep, medium- to fine-textured soils (morainal blankets or fluvial materials)

STAND COMPOSITION: Predominantly Douglas-fir and western redcedar

UNDERSTORY COMPOSITION:

Shrubs: Devil's club (E), red-osier dogwood (E)

Herbs: **Oak fern,** one-leaved foamflower, lady fern (D,E), star-flowered false Solomon's seal, baneberry, palmate colt's-foot, false lily-of-the-valley

TIMBER VALUE: Medium to good sites for timber production

VALUE TO DEER: This type has fair understory diversity. Forage potential is low to moderate, peaking in the spring when deer prefer herbs. The higher elevation sites may be unavailable during winter months. Other than minor amounts of evergreen herbs, there are very few forage species available during winter. Clearcutting increases herbs greatly, making the Oak fern understory type valuable as spring range, provided that suitable cover is close at hand.

VALUE TO ELK: Although the Oak fern type occupies the slope position and edatope usually of greatest value to elk, diet preferences indicate that the forage potential of this type is low. Devil's club is present in small amounts. Spring and summer use should be slightly greater than during winter.

OCEAN-SPRAY - TALL OREGON-GRAPE

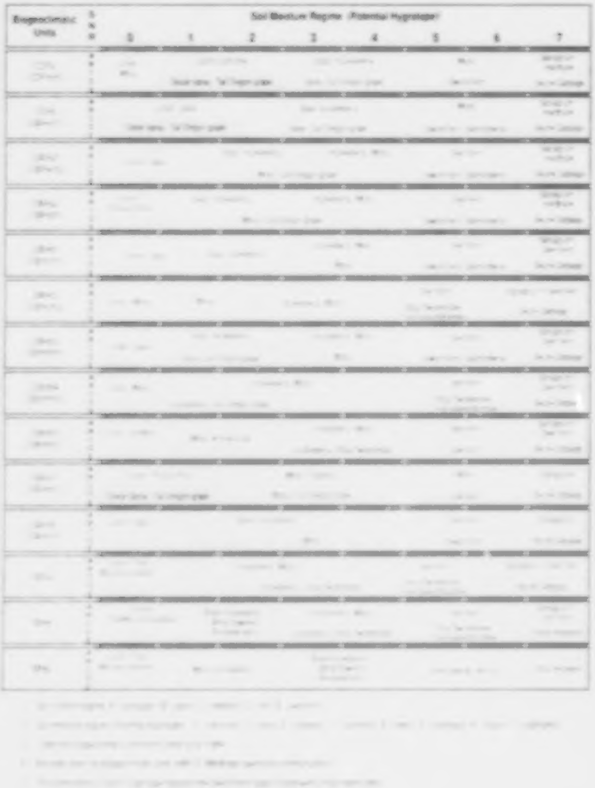


Figure 24. The position of the Ocean-spray - Tall Oregon-grape understory type on the biogeoclimatic unit/edatope matrix.

Table 19. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	**Spring**	**Summer**
Deer	Low	Low	Low
Elk	Low	Low	Low

LOCATION: On the coastal mainland and in the transitional area between maritime and continental climates

BIOGEOCLIMATIC UNITS: The Southern Drier Submaritime Coastal Western Hemlock Variant (**CWHc1**) and the Coastal Douglas-fir Zone (**CDF**)

SITE PROPERTIES:

Soil Moisture Regime: **0-2**

Soil Nutrient Regime: Medium to very rich (C-E) sites

Slope Position and Soil Features: Mainly on ridge crests and upper slopes with shallow, fine- to medium-textured soils, often associated with rock outcrops

STAND COMPOSITION: Predominantly Douglas-fir

UNDERSTORY COMPOSITION:

Shrubs: **Ocean-spray, tall Oregon-grape** (D)

Herbs: Grasses (D,E)

Mosses and Lichens: *Stokesiella oreganum, Pleurozium schreberi,* lichens (D)

TIMBER VALUE: Timber productivity on this type is low to poor because of the very dry soils.

VALUE TO DEER: Because these sites are very dry, tree growth is poor and arboreal lichen production is often high. In mature or late seral stages, some deer use is likely during winter, even though conifers and lichens are the primary forage sources. Spring is the time of highest use; stand conditions and slope position make early green-up likely.

VALUE TO ELK: No elk are present where this type occurs. Extrapolations from elk forage preferences and other needs suggest that this type would be of limited importance to elk.

ROSY TWISTEDSTALK - FIVE-LEAVED BRAMBLE

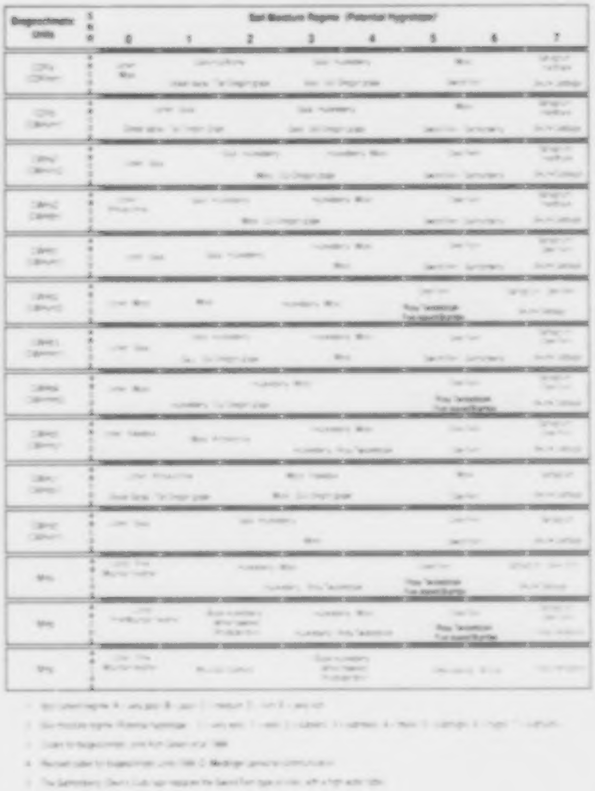


Figure 25. The position of the Rosy twistedstalk - Five-leaved bramble understory type on the biogeoclimatic unit/edatope matrix.

Table 20. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Low	Moderate	Moderate
Elk	Low	Moderate	Moderate

LOCATION: On Vancouver Island and the coastal mainland at moderate and high elevations

BIOGEOCLIMATIC UNITS: Windward and Leeward Montane Maritime Wetter Coastal Western Hemlock Variants (**CWHb2, CWHb4**) and Forested Mountain Hemlock Subzones (**MHa, MHb**)

SITE PROPERTIES:

Soil Moisture Regime: **4-6**

Soil Nutrient Regime: Medium to very rich (C-E)

Slope Position and Soil Features: Mainly on lower slopes and flats with deep, fine- to medium-textured soils

STAND COMPOSITION: Amabilis fir is the dominant tree species in all variants, with western redcedar being a major co-dominant in the CWHb2 and CWHb4. Redcedar is replaced at higher elevations (MHa, MHb) by yellow-cedar, and also by Engelmann spruce in the MHb.

UNDERSTORY COMPOSITION:

Shrubs: Salmonberry (E), stink currant, ninebark (E)

Herbs: **Rosy twistedstalk, five-leaved bramble**, sword fern (D,E), spiny wood fern, one-leaved foamflower, Indian hellebore

TIMBER VALUE: Medium to good sites

VALUE TO DEER: This understory type is found only in high-elevation areas that are typically unavailable from early winter to late spring because of very deep snow. Forage potential is moderate to low. Recent clearcuts are good foraging sites for deer during spring and summer because fireweed is usually abundant. Dense growth of amabilis fir and hemlock can quickly crowd out the understory and make a stand useful only as cover.

VALUE TO ELK: Winter use is precluded by deep snow. Spring and summer forage potentials are moderate.

SALAL - DULL OREGON-GRAPE

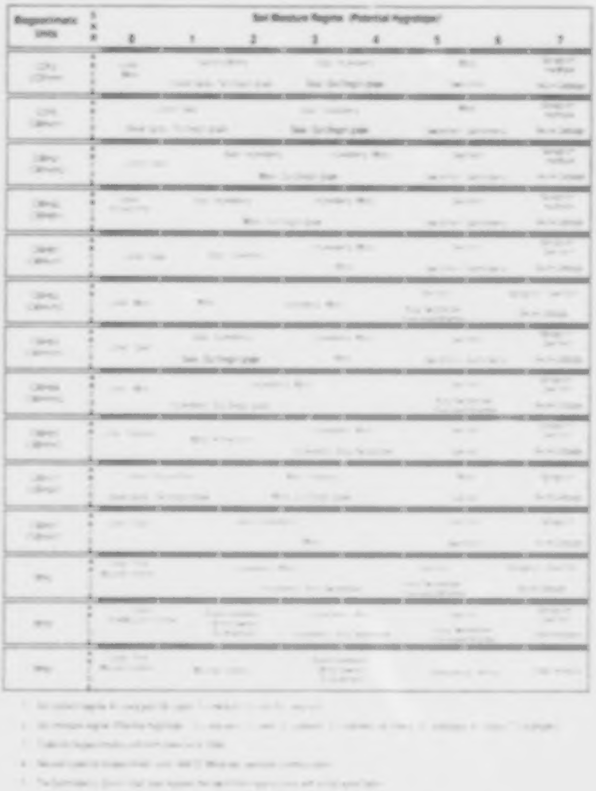


Figure 26. The position of the Salal - Dull Oregon-grape understory type on the biogeoclimatic unit/edatope matrix.

Table 21. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	High	Moderate	Moderate
Elk	Moderate	Low	Low

LOCATION: On southern and eastern Vancouver Island

BIOGEOCLIMATIC UNITS: The Coastal Douglas-fir Zone (**CDF**) and the Leeward Submontane Maritime Wetter Coastal Western Hemlock Variant (**CWHb3**)

SITE PROPERTIES:

Soil Moisture Regime: 3-4 in the CDF, and 1-2 in the CWHb3

Soil Nutrient Regime: Medium - very rich (C-E)

Slope Position and Soil Features: Mainly on upper slopes in the CWHb3. In the CDF, it also occurs on middle slope positions. On deep, medium-textured soils in both areas.

STAND COMPOSITION: Mainly Douglas-fir, but may have a minor amount of western redcedar and, in the CWHb3, western hemlock

UNDERSTORY COMPOSITION:

Shrubs: **Salal** (D,E), **dull Oregon-grape** (D,E), baldhip rose (D), trailing blackberry (D)

Herbs: Sword fern (D,E), vanilla-leaf, wall-lettuce (D), bracken (D), twinflower (E)

Mosses: ***Stokesiella oreganum***, *Rhytidiadelphus triquetrus*

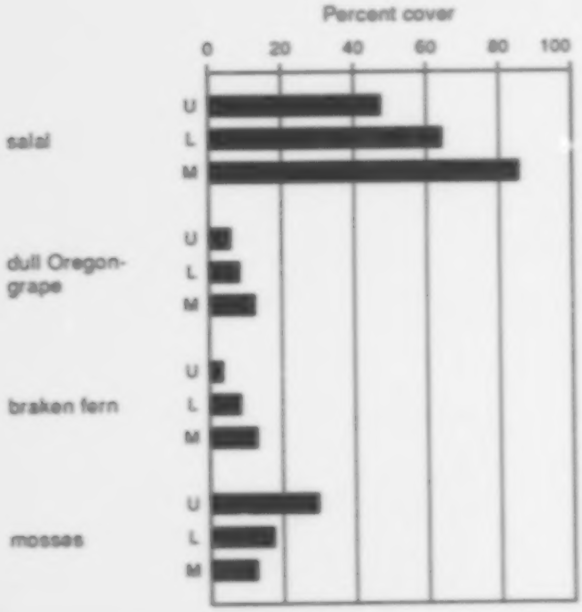
TIMBER VALUE: On the moister (**3-4**) sites in the **CDF**, productivity is medium to good. On the drier (**1-2**) sites in the **CWHb3**, Douglas-fir productivity is low to poor.

VALUE TO DEER: This understory type has almost the same forage potential as the Salal - Huckleberry understory type. The reduced abundance of huckleberries is offset by the presence of sword fern, vanilla-leaf, and more dull Oregon-grape. Salal still dominates the site, even though more herbs are present. At higher elevations in the CWHb3, the Salal - Dull Oregon-grape understory type may not be available to deer during winter because of deep snow. Spring and summer deer use is moderate, but winter use is heavy in mature stands on low elevation, south-facing slopes.

VALUE TO ELK: Although similar in forage potential to the Salal - Huckleberry understory type because of the dominance of salal, this type includes additional species that are preferred by elk and it is thus of somewhat higher value. Older successional stages receive greater use, especially in winter, because they provide snow interception cover.

FORESTRY EFFECTS:

Commercial Thinning - In stands suitable for commercial thinning, treatment enhances the abundance of understory vegetation. Because tree growth is poor, crown re-closure is slow. Woody shrubs (mainly salal and dull Oregon-grape) achieve dominance to the detriment of the small herbaceous species. Bracken will often do well, growing above the shrubs. The heavier the thinning, the more abundant the understory, as shown in Figure 27. Fertilization reduces the time to canopy re-closure, negating some of the benefits achieved through thinning.



Stand treatment	Tree density	Basal area
U - unthinned	4566/ha	42.8m²/ha
L - lightly thinned	1915/ha	32.0m²/ha
M - moderately thinned	886/ha	21.6m²/ha

Figure 27. Abundance of selected understory species and forage types in a Douglas-fir stand (site class = poor) thinned 25 years after establishment and sampled 11 years later (Nyberg et al. 1990a).

SALAL - HUCKLEBERRY

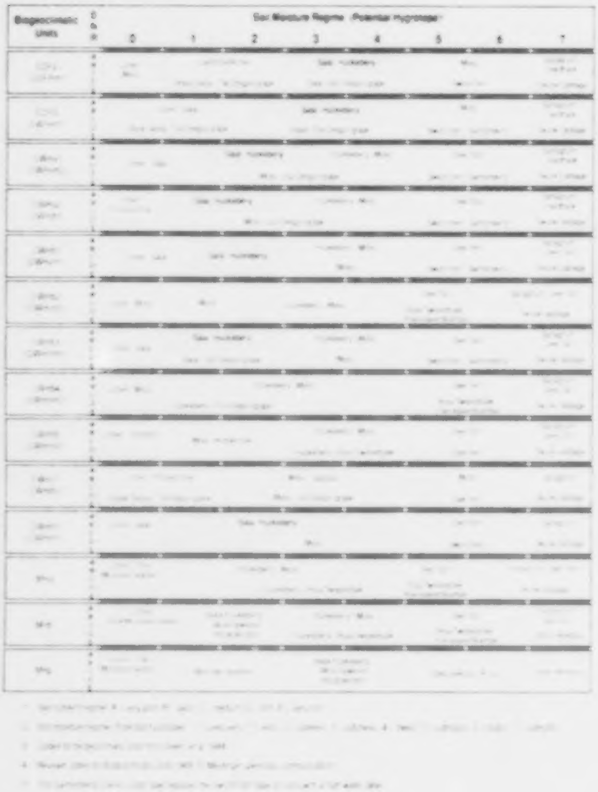


Figure 28. The position of the Salal - Huckleberry understory type on the biogeoclimatic unit/edatope matrix.

Table 22. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	High	Moderate	Moderate
Elk	Moderate	Low	Low

LOCATION: Throughout Vancouver Island and the mainland, in maritime climates at low elevations

BIOGEOCLIMATIC UNITS: The Coastal Douglas-fir Zone (CDF) and various maritime lower elevation variants of the Coastal Western Hemlock Zone (CWHa1, CWHa2, CWHbl, CWHb3, CWHd)

SITE PROPERTIES:

Soil Moisture Regime: **0-4**

Soil Nutrient Regime: Primarily very poor to medium (**A-C**), but in the wettest units (**CWHb1, CWHd**) may also be rich and very rich (**D-E**)

Slope Position and Soil Features: Mainly gentle to steep upper slopes except in the CDF, where it also occurs on coarse-textured, shallow to deep soils on middle slopes (morainal blankets, or colluvial or morainal veneers over bedrock), and on very coarse-textured soils on flatter areas (fluvial or glacio-fluvial)

STAND COMPOSITION: Primarily Douglas-fir at lower elevations, with increasing amounts of western hemlock as elevation and rainfall increase. May also have western redcedar and amabilis fir.

UNDERSTORY COMPOSITION:

Shrubs: **Salal** (D,E) **red huckleberry** (D,E), **Alaskan and oval-leafed blueberry** (CWHb1, CWHb3) (D,E), baldhip rose (D), dull Oregon-grape (D,E), trailing blackberry (D)

Herbs: Prince's pine, wall-lettuce (D), bunchberry (D,E), twinflower (E)

Mosses: ***Stokesiella oreganum,*** *Hylocomium splendens, Rhytidiopsis robusta, Rhytidiadelphus loreus*

TIMBER VALUE: The timber production of this type is low to poor for both Douglas-fir and western hemlock except in the CDF, where the Douglas-fir is of medium productivity, and in the CWHd, where hemlock is poor-medium. In the variants with drier moisture regimes (1-3) and on nutrient-very poor sites, these are marginal sites for timber production.

VALUE TO DEER: This type has the highest winter forage potential for deer, especially on south-facing slopes. In mature and old-growth stands, abundant arboreal lichens complement an understory dominated by salal and red huckleberry. Western redcedar, Douglas-fir, and western hemlock branches and litter are also available. During winters of deep snow, these forages provide the bulk of the deer diet. The ability of the overstory to intercept appreciable amounts of snow, thus providing deer with easier mobility and greater forage, has made mature stands on Salal - Huckleberry sites valued as deer winter range. Forage potential at other times of the year is lower because of a lack of succulent forage. In early seral stages (clearcuts), invasion of pioneer herbs such as hairy cat's ear, pearly everlasting, bracken, and minor amounts of fireweed can boost both forage abundance and diversity. Most Salal - Huckleberry understory types are burned prior to planting to reduce competition from salal. This aids establishing and maintaining herb forages preferred during spring and summer. High spring use and low to moderate summer use can be expected.

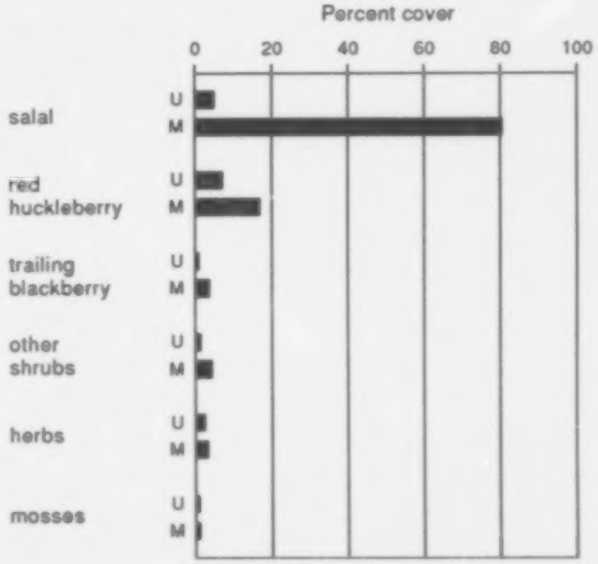
VALUE TO ELK: Although this understory type is fairly abundant at lower elevations, it receives little use by elk. Its forage potential is limited, except during the winter months when elk eat more huckleberry and conifers. Only those seral stages providing closed tree canopies are useful to elk in winter, and the extent of use then usually depends on an abundance of nearby rock outcrops or other desirable winter understory types. Use at other times of the year is also low.

FORESTRY EFFECTS:

Site Preparation and Regeneration: This type is usually burned following logging to reduce competition from salal. Douglas-fir is the preferred species, although western hemlock is often planted in the wetter subzones. Following burning, pioneer herbs (e.g., fireweed) often invade and increase substantially.

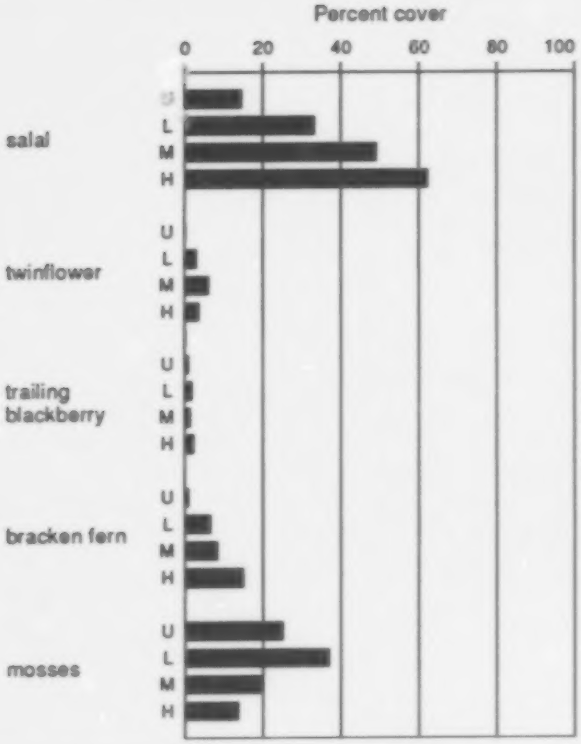
Non-Commercial Thinning: Non-commercial thinning, even if only of moderate intensity, provides large increases in salal abundance. Huckleberries respond less dramatically (Figures 29 and 30). Certain other forage species also show favourable responses to thinning: fireweed, trailing blackberry, and twinflower increased 3, 4, and 14 times, respectively, in one case (Nyberg *et al.* 1990a).

Commercial Thinning: In stands left untreated until commercial thinning age, understory vegetation is usually present in moderate amounts. The poor tree growth on these relatively unproductive sites allows substantial light to reach the ground. Response to thinning is not as dramatic as for non-commercial thinning. Salal, dull Oregon-grape, and bracken usually increase with thinning. Fertilization of lightly thinned stands tends to speed tree crown development, reducing light to the understory. Forage thus has less time to develop and may be shaded out sooner. In heavily thinned stands, fertilization should benefit understory vigour and quality because tree canopies remain open longer.



Stand treatment	Tree density	Basal area
U - unthinned	7500/ha	$46.7 m^2/ha$
M - moderately thinned	1400/ha	$14.4 m^2/ha$

Figure 29. Abundance of selected understory species and forage types in a Douglas-fir - western hemlock stand (site class = poor) thinned 19 years after establishment and sampled 5 years later (Nyberg et al. 1990a).



Stand treatment	Tree density	Basal area
U - unthinned	2442/ha	41.9m^2/ha
L - lightly thinned	712/ha	26.2m^2/ha
M - moderately thinned	568/ha	22.3m^2/ha
H - heavily thinned	309/ha	13.3m^2/ha

Figure 30. Abundance of selected understory species and forage types in a Douglas-fir stand (site class = medium) first thinned 21 years after establishment and sampled 13 years later (Nyberg et al. *1990a).*

SALMONBERRY - (DEVIL'S CLUB)

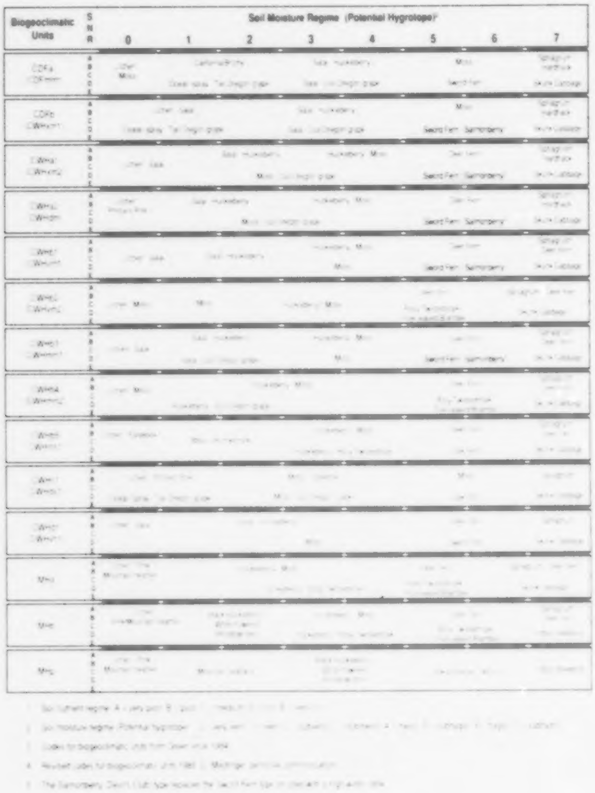

Biogeoclimatic Units
S N R
Soil Moisture Regime (Potential Hygrotope)
0
1
2
3
4
5
6
7

Figure 31. The position of the Salmonberry - (Devil's club) understory type on the biogeoclimatic unit/ edatope matrix.

Table 23. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Moderate	High	High
Elk	High	High	High

LOCATION: On Vancouver Island and the coastal mainland at low elevations

BIOGEOCLIMATIC UNITS: The Wetter Maritime Coastal Douglas Fir **(CDFb)** Subzone, and Coastal Western Hemlock variants in maritime areas at lower elevations **(CWHal, CWHa2, CWHbl, CWHb3)**

SITE PROPERTIES:

Soil Moisture Regime: Primarily **6**

Soil Nutrient Regime: Medium to very rich **(C-E)**

Slope Position and Soil Features: Mainly on gentle lower slopes and flats, and in draws and ravines; with deep, coarse- to fine-textured soils (morainal blankets, fluvial materials, organic blankets); and the water table within 30-50 cm of the surface

STAND COMPOSITION: Western redcedar is an important tree throughout, with grand fir in the drier climates (CDFb, CWHa1, CWHa2) and amabilis fir in wetter climates (CWHb1, CWHb3). Sitka spruce is also important in the CWHb1. Cottonwood may be planted in the drier climates.

UNDERSTORY COMPOSITION:

Shrubs: **Salmonberry** (D,E), devil's club (E), red elderberry (E), Sitka willow (D,E), stink currant, vine maple

Herbs: **Sword fern** (D,E), lady fern (D,E), three-leaved foamflower, northern bedstraw, Hooker's fairybells, vanilla-leaf, maidenhair fern, pathfinder, clasping twistedstalk, piggy-back plant, hedge-nettle

Mosses: *Leucolepis menziesii, Plagiomnium insigne, Hylocomium splendens, Rhytidiadelphus loreus*

TIMBER VALUE: These are good timber sites but often coniferous stands suffer from intense brush competition.

VALUE TO DEER: Deer use of this type is often high. It has a moderate to high forage potential and is usually available year-round, but snow may restrict use in the CWHb3 subzone. Winter forage includes vine maple, red elderberry, sword fern, and deer fern. The flat areas on which this community usually occurs accumulate more snow than the steeper, southerly slopes typically designated as critical deer winter ranges. During spring and summer, salmonberry sites provide abundant forage and receive moderate to heavy use.

VALUE TO ELK: Abundant shrubby and herbaceous forage at all times of the year make this type a favourite of Roosevelt elk. Use is heaviest during winter when migratory elk occupy low-elevation areas where it is common. Resident elk, however, use the Salmonberry understory type in all seasons, selecting salmonberry, devil's club, deer fern, and conifers year-round.

SITKA VALERIAN - ARNICA

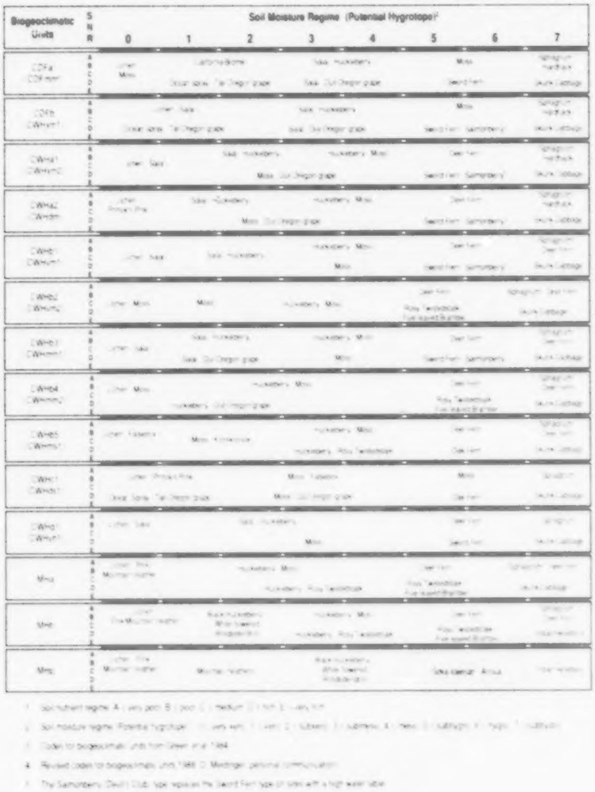


Figure 32. The position of the Sitka valerian - Arnica understory type on the biogeoclimatic unit/edatope matrix.

Table 24. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	**Spring**	**Summer**
Deer	Low	Moderate	Moderate
Elk	Low	Low	Low

LOCATION: On Vancouver Island and the coastal mainland at high elevations

BIOGEOCLIMATIC UNITS: The Parkland Mountain Hemlock Subzone (**MHp**)

SITE PROPERTIES:

Soil Moisture Regime: **5-6**

Soil Nutrient Regime: Very poor to very rich (**A-E**)

Slope Position and Soil Features: Mainly on lower slopes and flats with coarse- to fine-textured soils

STAND COMPOSITION: Scattered clumps of amabilis or subalpine fir, with mountain hemlock or Engelmann spruce

UNDERSTORY COMPOSITION:

Herbs: **Sitka valerian, asters, arnicas, paintbrushes, lupines,** fringed grass-of-Parnassus, sticky false asphodel, horsetail, Indian hellebore, Sitka burnet, sedges (D,E), marsh-marigold

TIMBER VALUE: Negligible timber production

VALUE TO DEER: Deer use is restricted to the summer-fall period because of heavy winter snows. As summer forage for migratory deer, the mixture of herbs in this understory type is valuable. Tree cover is sparse, but is important as a source of summer thermal and security cover.

VALUE TO ELK: Like the other understory types found in the Mountain Hemlock Parkland Subzone, the Sitka valerian - Arnica understory type has little value to elk. The species composition and abundance are inadequate to support many elk.

SKUNK CABBAGE

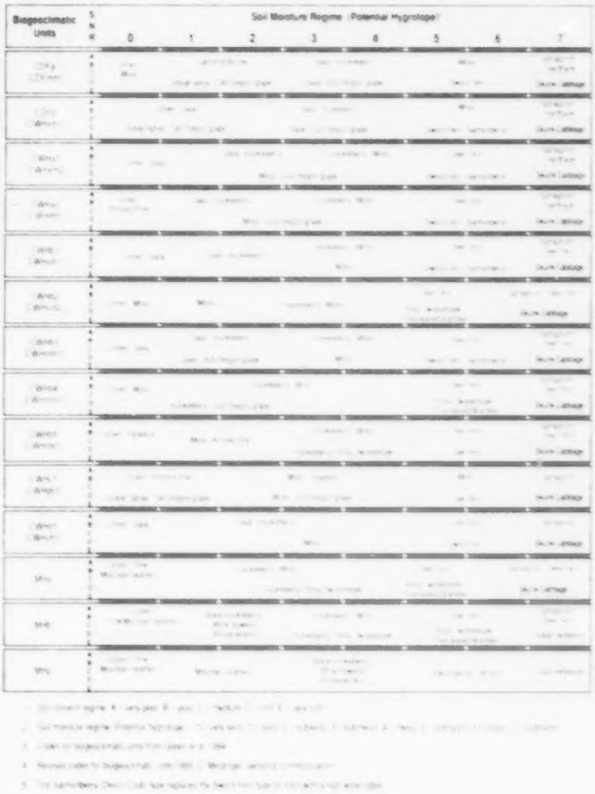


Figure 33. The position of the Skunk cabbage understory type on the biogeoclimatic unit/edatope matrix.

Table 25. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Moderate	High	Moderate
Elk	High	High	Moderate

LOCATION: Throughout Vancouver Island and the coastal mainland, except at high elevations

BIOGEOCLIMATIC UNITS: All except two Mountain Hemlock Subzones (MHb, MHp)

SITE PROPERTIES:

Soil Moisture Regime: 7

Soil Nutrient Regime: Medium to very rich (C-E)

Slope Position and Soil Features: Mainly on flats and depressions, with organic soils (organic veneers or blankets) over very fine-textured soils (lacustrine or fluvial materials), and the water table within 30 cm of the surface

STAND COMPOSITION: Western redcedar and western hemlock or, at high elevations (MHa), yellow-cedar and mountain hemlock. The hemlock species grow on acidic organic mounds.

UNDERSTORY COMPOSITION:

Shrubs: Salmonberry (D,E), devil's club (E), stink currant, red elderberry (E)

Herbs: **Skunk cabbage** (D,E) **lady fern** (D,E), deer fern (D,E), fern-leaved goldthread, bunchberry (D,E), Indian hellebore, three-leaved foamflower, oak fern, sedges (D,E) rushes, false bugbane

Mosses: *Plagiomnium insigne, Leucolepis menziesii, Kindbergia praelonga*

TIMBER VALUE: Poor to medium sites

VALUE TO DEER: This type receives moderate to high deer use, particularly during spring and summer when many preferred forages are available among the lush herbaceous vegetation. Pioneer species provide a slight increase in forage potential in recent clearcuts.

VALUE TO ELK: This understory type is one of the most preferred by elk. It has abundant forage all year. Elderberry, devil's club, conifers, and ferns are heavily used during winter. The forage value peaks in the spring with new growth of many forage species. Summer and fall use is also moderately high.

SPHAGNUM

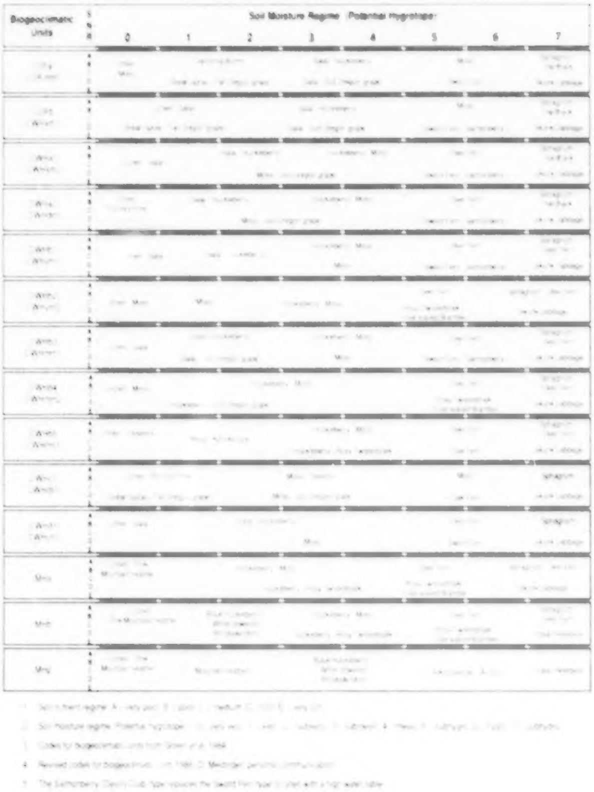


Figure 34. The position of the Sphagnum understory type on the biogeoclimatic unit/edatope matrix.

Table 26. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Low	Low	Low
Elk	Low	Low	Low

LOCATION: On Vancouver Island and the coastal mainland

BIOGEOCLIMATIC UNITS: The Southern Drier Submaritime Coastal Western Hemlock (**CWHc1**) and Hypermaritime Coastal Western Hemlock (**CWHd**) Variants

SITE PROPERTIES:

Soil Moisture Regime: **7**

Soil Nutrient Regime: Very poor to medium (**A-C**)

Slope Position and Soil Features: Mainly in depressions, with organic soils (organic blankets or veneers) over fine-textured soils, and the water table within 30 cm of the surface

STAND COMPOSITION: Very open stands of lodgepole pine and western redcedar

UNDERSTORY COMPOSITION:

Shrubs: Labrador tea, bog-laurel, crowberry, bog cranberry, bog blueberry

Herbs: Sedges (D,E), marsh-marigold, great burnet, sticky false asphodel, narrow-leaved cotton-grass, round-leaved sundew

Mosses: **Sphagnum**

TIMBER VALUE: Negligible timber production

VALUE TO DEER: This understory type is of low value to deer but attracts some use during spring when sedges and a variety of succulent herbs emerge. The high water table limits shrubs to hummocks and mounds at the bases of large trees.

VALUE TO ELK: This understory type has low forage potential for Roosevelt elk, primarily because of its low forage biomass. Spring and summer bring some elk use, when sedges and herbs are succulent.

SPHAGNUM - DEER FERN

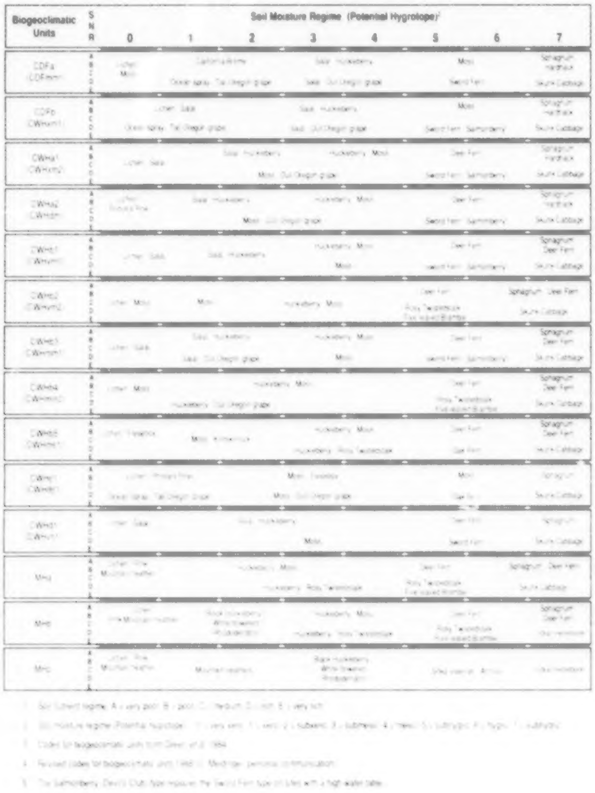


Figure 35. The position of the Sphagnum - Deer fern understory type on the biogeoclimatic unit/ edatope matrix.

Table 27. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Low	Low	Low
Elk	Low	Low	Low

LOCATION: On Vancouver Island and the coastal mainland, in wet climates and high snowfall areas

BIOGEOCLIMATIC UNITS: The Wetter Coastal Western Hemlock Subzone (**CWHb1, CWHb2, CWHb3, CWHb4,** and **CWHb5** Variants) and the Forested Mountain Hemlock Subzones (**MHa** and **MHb**)

SITE PROPERTIES:

Soil Moisture Regime: **7**

Soil Nutrient Regime: Very poor to medium (**A-C**)

Slope Position and Soil Features: Mainly in depressions with organic soils (organic veneers or blankets) over fine-textured soils (lacustrine or fluvial materials) and the water table within 30 cm of the surface

STAND COMPOSITION: A very open canopy of lodgepole pine and western redcedar

UNDERSTORY COMPOSITION:

Herbs: **Deer fern** (D,E), bog-rosemary, narrow-leaved cotton-grass, sedges (D,E), deer-cabbage, round-leaved sundew, bog blueberry, great burnet, bog cranberry

Mosses: **Sphagnum**

TIMBER VALUE: Negligible timber production

VALUE TO DEER: The Sphagnum - Deer fern understory type is of low value to deer at all times of year because it has few preferred forage plants. Deer fern, while usually present, is seldom abundant; preferred shrubs are very scarce. Sedges and other herbs attract some deer use during the growing season.

VALUE TO ELK: Although the Sphagnum - Deer fern understory type is often unavailable during winter and has little forage, it often lies between heavily used bogs and denser forests. Consequently, it receives some use both as cover and a foraging habitat.

SPHAGNUM - HARDHACK

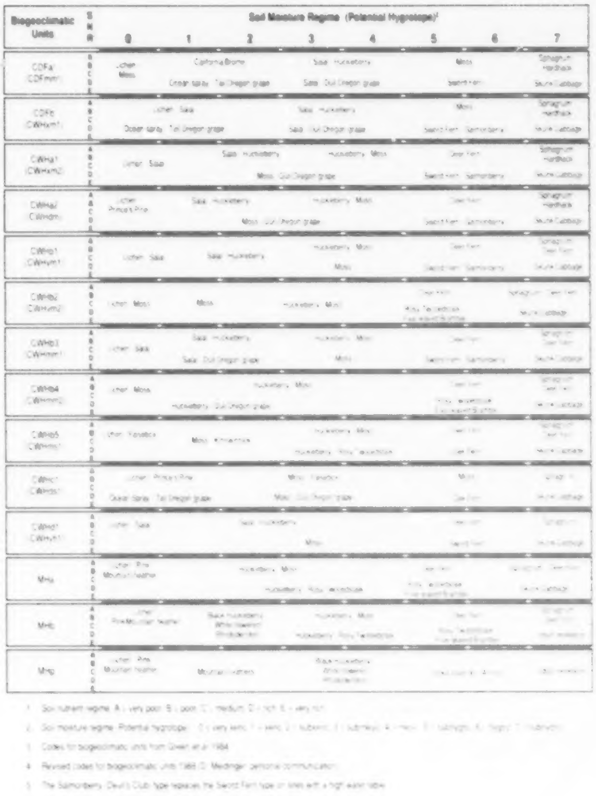

Biogeoclimatic Units
SNR
Soil Moisture Regime (Potential Hygrotope)
0
1
2
3
4
5
6
7

Figure 36. The position of the Sphagnum - Hardhack understory type on the biogeoclimatic unit/edatope matrix.

Table 28. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Low	Low	Low
Elk	Low	Low	Low

LOCATION: On Vancouver Island and the coastal mainland in areas with a dry, maritime climate

BIOGEOCLIMATIC UNITS: The Coastal Douglas-fir Zone (**CDF**) and the Drier Coastal Western Hemlock Subzone (**CWHal, CWHa2**)

SITE PROPERTIES:

Soil Moisture Regime: **7**

Soil Nutrient Regime: Very poor to medium (**A-C**)

Slope Position and Soil Features: Mainly in depressions, with organic soils (organic veneers or blankets) over fine-textured soils (fluvial or lacustrine materials), and the water table within 30 cm of the surface

STAND COMPOSITION: A very open canopy of lodgepole pine and western redcedar

UNDERSTORY COMPOSITION:

Shrubs: **Hardhack,** sweet gale

Herbs: Sedges (D,E), grasses (D,E), narrow-leaved cotton-grass

Mosses: **Sphagnum**

TIMBER VALUE: Negligible timber production

VALUE TO DEER: This understory type, a lower elevation version of the Sphagnum - Deer fern type, contains more shrubs (mainly hardhack and sweet gale). Its forage potential is low, however, because these species are not preferred forages. Use is greatest in the spring, when new growth of sedges and forbs first appears.

VALUE TO ELK: Forage production of the Sphagnum - Hardhack understory type is low, but its location adjacent to preferred habitats often results in substantial elk use. This type is common adjacent to bogs and meadows.

SWORD FERN

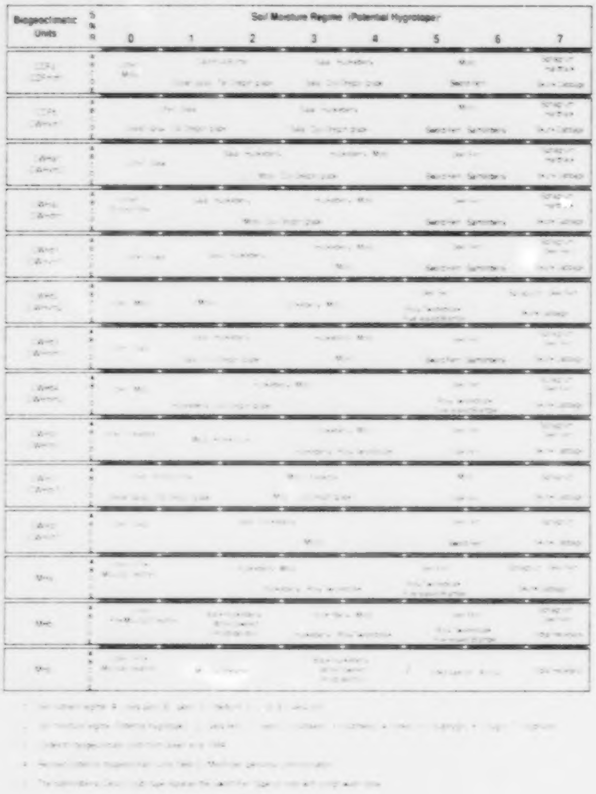


Figure 37. The position of the Sword fern understory type on the biogeoclimatic unit edatope matrix.

Table 29. Potential forage values, by season, for deer and elk

Species	Season		
	Winter	Spring	Summer
Deer	Moderate	High	High
Elk	High	High	High

LOCATION: On Vancouver Island and the coastal mainland at lower elevations, except in areas influenced by the continental climate (submaritime areas)

BIOGEOCLIMATIC UNITS: The Coastal Douglas-fir Zone (**CDF**) and Coastal Western Hemlock Variants at lower elevations with a maritime influence **(CWHa1, CWHa2, CWHb1, CWHb3, CWHd)**

SITE PROPERTIES:

Soil Moisture Regime: Primarily **5-6**

Soil Nutrient Regime: Medium to very rich **(C-E)**

Slope Position and Soil Features: Mainly on lower slopes and flats receiving moisture, with deep, fine- to coarse-textured soils (morainal blankets, glacio-fluvial, fluvial, and lacustrine deposits)

STAND COMPOSITION: Western redcedar with Douglas-fir and grand fir as co-dominants in drier climates (CDF, CWHa1, CWHa2, CWHb3) and amabilis fir and Sitka spruce in wetter climates (CWHb1, CWHd)

UNDERSTORY COMPOSITION:

Shrubs: Red huckleberry (D,E), devil's club (E), salmonberry (D,E), vine maple (D)

Herbs: **Sword fern** (D,E), vanilla-leaf, one-leaved foamflower, three-leaved foamflower, deer fern (D,E), lady fern (D,E), spiny wood fern, five-leaved bramble, rosy twistedstalk

Mosses: *Leucolepis menziesii, Plagiomnium insigne, Rhytidiadelphus triquetrus*

TIMBER VALUE: These are good sites for all tree species listed. In the CWHa, these are the most productive sites for Douglas-fir in British Columbia.

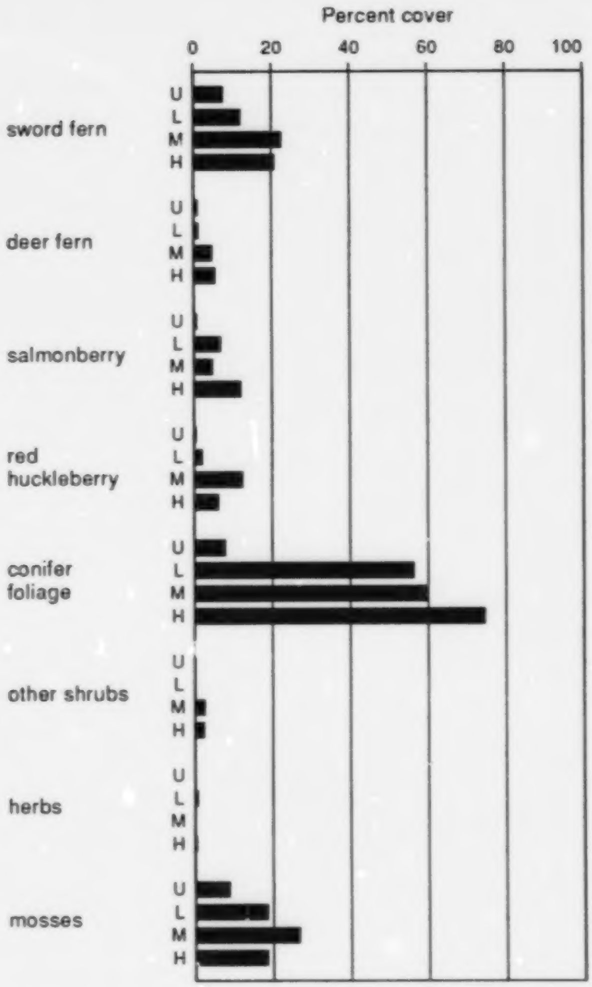
VALUE TO DEER: Most units of the Sword fern understory type are accessible to deer during all seasons. Many winter ranges incorporate small sword fern sites or lie just upslope from them. When snow is shallow, these inclusions are valuable foraging areas. In addition to sword fern, deer seek the huckleberry, salmonberry, and minor herbs that grow there. Spring and summer forage potentials are high because of the abundance of herbs. Early seral stages provide minor changes in forage through the invasion of small herbs. This barely offsets the loss of sword fern from site disturbance or its reduced palatability due to exposure to the sun.

VALUE TO ELK: This type has high forage potential for elk year-round. Because most sites are found at low elevations, they can often be used as wintering areas. Older coniferous stands are best in winter: snow interception by well-developed canopies makes ferns available when forage in open-canopied stands is buried. Under low snow conditions, deciduous stands are also used. Preferred forage such as deer fern, salmonberry, devil's club, and sword fern are fairly abundant and easily accessible on the gentle slopes and flats on which the Sword fern understory type develops. Spring and summer use is also high. These sites are also often adjacent to prime habitat such as the Salmonberry and Skunk cabbage understory types.

FORESTRY EFFECTS:

Site preparation and regeneration: Sword fern sites, having moist, rich soils with organic matter incorporated into the mineral component, withstand slashburning well. This understory type responds quickly following fire, providing abundant spring and summer forage for deer and elk. On some sites, ferns dominate; on others, abundant salmonberry can cause brush problems. On these latter sites, chemical or mechanical control is often used to allow conifer release; these practices 6can lead to loss of valuable forage for deer and elk.

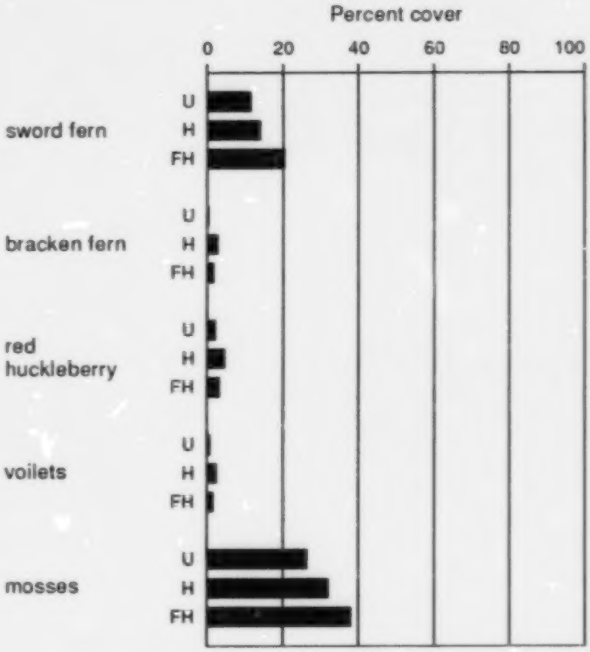
Non-Commercial Thinning: Thinning results in substantial increases in sword fern abundance. Responses of other understory species depend on the nature of the site. In a herb-dominated stand thinned at moderate intensity, Nyberg *et al*. (1990a) noted an increase in sword fern from 9 to 33% cover, with no change in abundance of other species. In a thinning trial in the CWHb1, all species groups showed greater abundance in treated stands (Figure 38). Western hemlock regrowth and lower branches accounted for almost all of the conifer cover, and may have reduced responses of other plants by shading them out.



Stand treatment	Tree density	Basal area
U - unthinned	10670/ha	55.6m^2/ha
L - lightly thinned	2220/ha	34.7m^2/ha
M - moderately thinned	1360/ha	26.2m^2/ha
H - heavily thinned	660/ha	23.2m^2/ha

Figure 38. Abundance of selected understory species and forage types in a western hemlock stand (site class = medium) thinned 13 years after planting and sampled 8 years later (Nyberg et al. *1990a).*

Commercial Thinning: Tree densities at commercial thinning age are often relatively low. Thinning may provide only small increases in the amount of light reaching the understory, so forage responses are not large. Fertilization associated with thinning had a noticeable effect on the amount of forage in one study (Figure 39), especially on the abundance of sword fern, which increased appreciably.



Stand treatment	Tree density	Basal area
U - unthinned	671/ha	63.6m²/ha
H - heavily thinned	420/ha	43.4m²/ha
FH - fertilized, heavily thinned	420/ha	45.0m²/ha

Figure 39. Abundance of selected understory species and forage types in a Douglas-fir - western hemlock stand (site class = good) thinned 44 years after establishment and sampled 7 years later (Nyberg et al. *1990a).*

APPENDIX 2. SPECIAL HABITATS

ALPINE AND SUBALPINE MEADOWS

In the handbook area, alpine and subalpine meadows are generally found above 1200 m elevation, in the parkland portion of the Mountain Hemlock biogeoclimatic zone, and in the Alpine Tundra zone (Nuszdorfer *et al.* 1985). Patches of forest occur at the lower elevations but, above the parkland areas, trees are stunted as a result of the short growing season and severe climate. Terrestrial lichens and mosses are most abundant on ridge crests and upper slopes, but give way to heathers, sedges, and herbs (e.g., partridge-foot, louseworts, saxifrages, and valerian) downslope. Depressions with deep soils and abundant seepage moisture often hold lupines, arnica, and other tall herbs.

VALUE TO DEER: Deep snows prevent deer use in winter and the delayed growing season makes alpine and subalpine meadows of little value in spring. As summer range, however, open meadows and parkland are valuable to migratory deer. Although forage density is low on average, deer preferences and feeding habits allow them to do well in the richer areas (lower elevational limits). Cover, shade, and water sources are usually available in the forested patches of the subalpine parkland.

VALUE TO ELK: Most alpine and subalpine meadows are of little value to Roosevelt elk, primarily because the low density of forage cannot support a large group of elk for any length of time. As shown by studies in drier climates, the relative lack of water in alpine areas may limit elk use in some areas. More productive foraging areas are sometimes available at lower elevations within subalpine meadows. Where those meadows are abundant, they can be an important component of elk summer range.

RIPARIAN AREAS

In riparian areas, the vegetation and microclimate are influenced by perennial or intermittent water, or both (Brown 1985). Riparian habitat includes a variety of moist, rich understory types. Sword fern, Salmonberry, Skunk cabbage and Oak fern understory types are commonly part of the riparian complex. Such areas are usually flat or gently sloping, and often form a narrow band of habitat adjacent to a river, stream, or lake. Floodplains of major rivers may, however, be a kilometre or more wide. Riparian areas along watercourses tend to be richer in vegetation than those around lakes, with lakeshores often being dominated by shrubs such as red-osier dogwood or ninebark.

Deciduous trees are common components of riparian habitats along watercourses. Their open canopies usually allow abundant light to reach the understory, enhancing forage production. Similarly, old-growth conifer stands on floodplains are often open and abundant in forage. Dense regenerating conifer stands severely reduce the amount of light received by the understory and may restrict the rich riparian vegetation to a narrow band adjacent to the water.

VALUE TO DEER: Riparian areas are valuable foraging areas for deer, particularly during spring and summer when herbs are most abundant. Shrubs and ferns are often abundant as well, and are eaten year-round. Forage potential is high as a result of the abundance of species such as salmonberry, red elderberry, sword fern, deer fern, and numerous small herbs. Winter use of riparian habitat is common but greatly reduced by deep snow, especially where the overstory is deciduous.

VALUE TO ELK: Roosevelt elk make heavy use of riparian habitat at all times of the year. Potential forage production is very high. Many riparian areas along rivers and streams produce ample quantities of salmonberry, red elderberry, assorted ferns, twinflower, vanilla leaf, and small herbs. Non-migratory elk may spend the whole year on the wide riparian zones of river floodplains. Migratory herds also take advantage of the prime forage in riparian areas, both travelling to and roaming on their summer ranges. On the lower elevation winter ranges, riparian habitats are frequently used when snow depths are low. The open fringes along streams and lakes allow snow to melt, making food (especially ferns) more easily available. Riparian areas with an overstory of old-growth coniferous forest provide the most valuable winter range for elk during moderate and severe winter conditions.

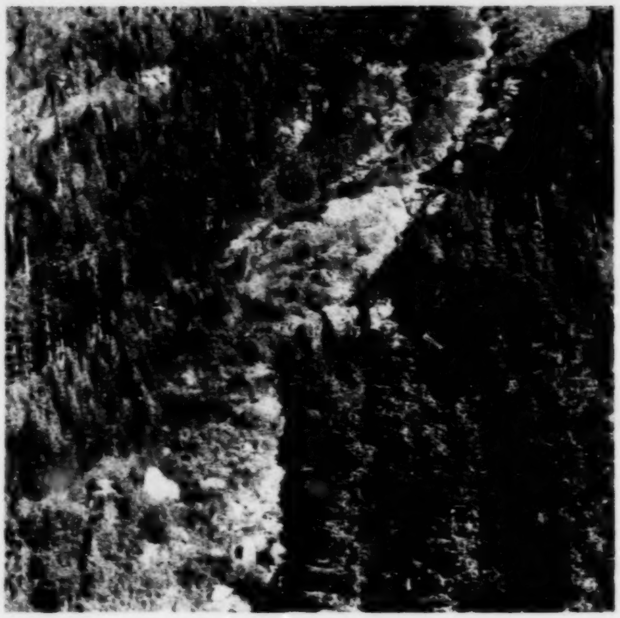
ROCK OUTCROPS

Rock outcrops, namely patches of exposed bedrock and associated very shallow soils, are usually extremely dry sites. They are common on ridge crests and steep slopes, and are often occupied by understory types with abundant terrestrial lichens. Rock outcrops are most important to deer and elk on winter and spring ranges, especially when situated on unshaded south-facing hillsides with moderate to steep slopes. They often provide important diversity within stands that otherwise are dense and uniform. Forage production is limited on the most rocky areas (see the Lichen-Falsebox, Lichen - Moss, Lichen - Prince's pine, and Lichen - Salal understory types), but grasses, some forbs, and occasional shrubs are present. The edges of rock outcrops support more forage because moisture is more abundant and soils are deeper. Forage species such as sword fern, salal, trailing blackberry, western redcedar, and baldhip rose do well on the edges. Coniferous stands around rock outcrops provide important security cover and thermal cover.

VALUE TO DEER: Deer often make heavy use of slopes where rock outcrops are most abundant. Rock outcrops receive year-round use. Small rock outcrops are preferred because they provide sheltered vantage points from which deer can watch for predators; steep outcrops can function as escape terrain. Although forage potential is not high, exposure to direct solar radiation allows forage on rock outcrops to green-up early in the spring. During winter, small rock outcrops on winter ranges provide canopy breaks where deer can exploit the heat of the sun. The steepness and exposure to wind of some outcrops reduce accumulations of snow, giving deer better mobility and greater access to forage.

VALUE TO ELK: Rock outcrops can also be of special importance to elk in winter and spring. Exposed south-facing rock outcrops (110-250°) with slopes between 10 and 50% are most valuable to elk. During winters with deep snow, elk frequently move to areas of abundant rock outcrops because these provide shallower snowpacks as a result of wind erosion and increased melt associated with exposure to solar radiation. They also yield thermal advantages on sunny days and some preferred forage (grasses and evergreen shrubs) that may be exposed by melt or digging by the elk. Most forage must be obtained from the area surrounding the outcrops, however. Elk also use rock outcrops in spring when residual snow prevents use of preferred foraging areas elsewhere. They seldom use outcrops during summer and fall because in these snow-free months better foraging opportunities are available in other habitats.

VEGETATED SLIDES



Vegetated slides include avalanche chutes and other currently and recently active landforms. They are most common in the upper reaches of mountainous drainages. On north-facing slopes, vegetated slides generally accumulate deep snow which melts slowly in the spring. The growing season on such slides is short because the elevation, aspect, and snow cover combine to delay green-up. This delay provides succulent, high-quality forage late in the growing season when annual growth of forage on other sites has matured and become desiccated. Vegetated slides have no overstory, although Sitka alder can provide a dense, low canopy. Vegetation is usually abundant, especially on the lower slopes where salmonberry often dominates. The shrub component may also include willows, red elderberry, huckleberry, devil's club, and thimbleberry. The herb layer is usually diverse, with large amounts of rosy twistedstalk, foamflower, false bugbane, lady fern, oak fern, Indian hellebore, and numerous other small annual herbs.

VALUE TO DEER: Vegetated slides are rarely accessible during winter. They are a valued habitat to migratory deer the rest of the year, especially in unlogged areas where open areas with abundant forage are rare. The forage potential of vegetated slides is high because of the plentiful forage species. Delayed plant development on high-elevation slides makes preferred forage available into the fall. Vegetated slides have no timber value, but harvesting of trees adjacent to them may limit deer use until sufficient security cover has developed.

VALUE TO ELK: Vegetated slides and avalanche chutes are highly preferred by elk during summer and fall. Forage abundance and diversity is high, and cover on and adjacent to slides is often excellent as well. Large slide complexes can support elk herds for most of the summer and fall period. Slides on north aspects are often preferred, since they provide some shade even in the absence of vegetative cover. Cooler air flowing down slides (especially avalanche chutes) and over unmelted snow can provide relief from insects and mid-day heat.

WETLANDS

In our definition, wetlands include non-forested estuaries as well as the bogs, fens, swamps, and marshes included in the Canadian Wetland Classification scheme (National Wetlands Working Group 1988). In the following description the emphasis is on what are locally called bogs, since they are most abundant in the handbook area. Bogs are characterized by high water tables and can be found on flat areas at most elevations. The dominant vegetation of bogs is usually grasses or sedges, but they may also have significant amounts of sweet gale or hardhack. Pure sphagnum bogs are also found.

VALUE TO DEER: Bogs are only lightly used by deer. Sedges are not heavily used, but the other herbs may be highly preferred summer and fall forages.

VALUE TO ELK: Bogs with sedges or shrubs are highly valued elk habitats, receiving moderate to heavy use when not snow-covered. Vegetation in low-elevation wetlands greens-up early in the year due to the absence of an overstory canopy and often provides elk with an abundance of preferred forage (mainly sedges, grasses, and forbs). Additional forages such as red-osier dogwood, hardhack, and ninebark are often present in riparian areas at the periphery of wetlands. The habitats that surround open wetlands often receive heavy elk use because they provide cover. Forestry practices in these stands can strongly influence elk use of the wetlands.

APPENDIX 3. GLOSSARY

The definitions below have been drawn mainly from two sources: Webster's Ninth New Collegiate Dictionary, 1986 edition (WNC) (Mish 1986), or the Terminology of Forest Science, Technology, Practice and Products (Ford-Robertson 1983) (TFP). Where these sources do not provide a suitable definition of a strictly local term or of a specialized meaning in wildlife science (e.g., security cover), the WNC or TFP definition has been modified slightly (indicated by an asterisk *); a definition has been quoted or paraphrased (paraphrasing is indicated by an asterisk *) from elsewhere (reference listed in parentheses); or a new definition has been drawn up (indicated by a double asterisk **).

advance growth: young trees that have become established naturally before regeneration cuttings are begun or a clearcutting is made (TFP)

allowable annual cut: the rate of timber harvesting specified for an area of land (Forest Act, RSBC Chapter 140, 1979)

backlog spacing: non-commercial thinning of stands past the prime age for first thinning (generally more than 20 years old) **

bole: the trunk of a tree (WNC)

broadcast burning: allowing a controlled fire to burn over a designated area within well-defined boundaries, to reduce fuel hazard, as a silvicultural treatment, or both (TFP)

brushing: see **cleaning**

canopy closure: in a crop or stand, the progressive reduction of space between crowns as they spread laterally (TFP)

capability: the potential of an area to produce a specific crop under specified technological controls (Hills *et al.* 1973)

carrying capacity: the number of organisms of a given species and quality that can survive in, without causing deterioration of, a given ecosystem through the least favourable environmental conditions that occur within a stated interval of time (TFP)

cleaning: a loose term for eliminating or suppressing undesirable vegetation, mainly woody, before or along with the first thinning so as to favour the better trees; may include unwanted crop species (TFP*)

clearcutting: removal of all the trees in a stand of timber (WNC*); **clear-cut** (verb); **clearcut** (noun)

climax forest: a community that represents the culminating stage of a natural forest succession for its locality, i.e. for its environment (TFP)

commercial thinning: any type of thinning producing merchantable material at least to the value of the direct costs of harvesting (TFP)

critical snowpack: for deer or elk, a snowpack ≥ 45 cm deep persisting 30 days or more **

critical winter range: forested habitat, usually stands of mature or old-growth conifers, which provides deer and elk with resources critical to survival during severe winters **

crown completeness: the proportion of the sky obliterated by tree crowns within a defined angle (or determined with a described instrument) from a single point (Bunnell *et al.* 1985a)

cutblock: specified area of land selected for timber harvesting **

dry-matter digestibility: the relative amount of ingested matter or energy, excluding feces, after removal of all water (Robbins 1983*)

ecotone: a transition area between two adjacent ecological communities usually exhibiting competition between organisms common to both (WNC)

edaphic: of or relating to the soil (WNC)

edatope: refers to a specific combination of soil moisture regime and soil nutrient regime (Pojar *et al.* 1987)

edge: the more or less well-defined boundary between two or more elements of the environment; e.g., field and woodland (TFP)

ericaceous: of, relating to, or being a heath or heath family (WNC)

escape cover: see **security cover**

establishment: the process of developing a crop to the stage at which the young trees may be considered established (i.e., safe from normal adverse influences — e.g., frost, drought, weeds, or browsing — and no longer in need of special protection or special tending), but only routine cleaning, thinning, and pruning (TFP)

forage: the edible vegetation for wildlife produced seasonally or annually on a given area (TFP*)

graminoids: grasses and grasslike plants, including sedges and rushes**

green pruning: the considered removal of live branches (TFP*)

green-up: establishment of a stand of young conifers that provides security cover **

habitat: the place or type of site where a plant or animal naturally or normally lives and grows (WNC)

hiding cover: see **security cover**

home range: the area which an animal traverses in the scope of normal activities (Thomas 1979)

horning: rubbing and thrashing of hard antlers on vegetation as part of a social display (Geist 1981)

immature forest: a loose term applied to all stages of a forest after it is established and before it becomes mature **

juvenile spacing: see **non-commercial thinning**

landing: any place where timber is assembled for further transport, commonly with a change in method (TFP)

lift: a pruning treatment, usually one of a series applied to a tree **

limited entry hunt: a hunting season for which a limited number of hunting authorizations are issued by means of a lottery or other method of random selection among applicants (Wildlife Act, SBC Chapter 57, 1982)

limiting factor: a factor present in an environment in such short supply that it limits growth or some other life process (Holmes 1979)

mainline: a principal timber extraction road **

mature forest: a loose term for the stage at which trees in a narrowly even-aged stand attain full development, particularly height, and full seed production. Thereafter, a decline in vigour, health, and soundness marks the stage of overmaturity (TFP*)

mean crown completeness: a stand measure determined from a number of crown completeness measures (Bunnell *et al.* 1985a)

merchantable: of trees, crops, or stands, of a size, quality, and condition suitable for marketing under given economic conditions, even if so situated as not to be immediately accessible for logging; of a bole or stem, the parts suitable for sale (TFP)

non-commerical thinning: a thinning operation in which non-merchantable trees are felled; usually the thinned stems are left on the ground in the stand **

old growth: an over-mature seral forest or climax forest typified by patchiness, large trees, multiple vegetation layers, and abundant snags and large down logs **

operative temperature: the effective temperature experienced by an animal as a result of the combined effects of air temperature, wind speed, solar radiation, and humidity **

organic horizon: a layer of soil or soil material approximately parallel to the land surface containing 17% or more organic carbon * (Can. Dep. Agric. 1976)

partial cutting: tree removal other than a clearcutting; i.e., taking only part of the stand (TFP)

phenology: characteristic periodic phenomena in the life cycle of organisms in nature, e.g., flowering and leaf-fall in plants (TFP*)

pre-commercial thinning: see **non-commercial thinning**

prescribed burning: controlled application of fire to fuels under such conditions of weather, fuel moisture, soil moisture, etc., as allow the fire to be confined to a predetermined area and at the same time to further certain planned objectives of silviculture, wildlife management, grazing, fire-hazard reduction, etc. (TFP **)

progressive clearcutting: a harvesting regime in which adjacent cutblocks are successively clear-cut over a portion of the rotation period **

pruning: the considered removal, close to or flush with the stem, of side branches, live or dead, and of multiple leaders from a standing, generally plantation-grown tree, for the improvement of the tree or its timber (TFP)

pruning lift: see **lift**

raghorn: 2-year-old bull elk with small, often asymmetrical antlers, frequently having broken tines **

range: see **habitat**

reforestation: re-establishment of a tree crop on forest land (TFP)

regeneration: the renewal of a tree crop, whether by natural or artificial means (TFP)

regime: a systematic plan designed to improve and maintain the health of a forest stand (WNC*)

release: freeing a tree or group of trees from immediate competition by cutting, or otherwise eliminating, growth that is overtopping or closely surrounding them (TFP*)

riparian: relating to or living or located on the bank of a natural watercourse (as a river) or sometimes of a lake or tidewater (WNC)

root rot: a rot that occurs chiefly in the roots of trees or in the roots of seedlings that have developed woody stem tissues (Dollinger and Borden 1984)

rotation: the planned number of years between the formation or regeneration of a crop or stand and its final cutting at a specified stage of maturity (TFP)

rotational logging: a harvesting regime that delays logging of successive blocks of timber (i.e., "rotates" them) around designated critical winter ranges to ensure more or less continuous production of the early successional vegetation that is typically found in clearcut areas for the first 10-15 years after logging **

ruminant: of or relating to a suborder (*Ruminantia*) of even-toed hoofed mammals that chew the cud and have a three- or four-chambered stomach (WNC)

scarification: loosening the top soil of open areas, or breaking up the forest floor, in preparation for regenerating by direct seeding or natural seedfall (TFP)

second growth: a stand of timber that has replaced a former or old-growth stand, and is in an immature and thrifty condition (Pearse 1976); see also **immature forest**

security cover: vegetation structure or topographic features, or both, that provide an animal with security or a means of escape from the threat of predators or harassment (Skovlin 1982*)

selective cutting: cutting that removes only certain species above a certain size, known silvicultural requirements and/or sustained yields being wholly or largely ignored or found impossible to fulfill (TFP*)

silviculture: the theory and practice of controlling the establishment, composition, constitution, and growth of forests (TFP)

site preparation: any planned measure to prepare a site for the favourable reception and satisfactory growth of either naturally or artificially disseminated seed or planted seedlings (B.C. Ministry of Forests 1982, revised)

site rehabilitation: see **species conversion**

skidder: a mechanized piece of logging equipment used to drag or slide logs from the cutting area to the landing (Dean and Evans 1984)

slash: the residue left on the ground after felling and tending, or that accumulates as a result of storm, fire, girdling, poisoning, disease, or pests (TFP*)

slashburning: use of prescribed fire to reduce slash, prepare the site for planting, and decrease the risk of wildfire **

snag: a standing dead tree from which the leaves and most of the branches have fallen (TFP)

snow-interception cover: a stand of conifers at least 10 m in height and with 60-90% canopy closure that provides relatively shallow snow depths and abundant available forage compared to other stands **

spacing: tree distribution at the time of planting **, see also **thinning**

spacing density: the number of live trees remaining after thinning **

species conversion: a change from one tree species to another (e.g., from broad-leaved to conifer) (TFP)

spike: a male deer or elk with single-point antlers **

spot burning: a modified form of broadcast burning in which only the larger accumulations of slash are fired and the fire is confined to these spots (TFP)

spur: a small branch of a logging road **

stand: a community, particularly of trees, possessing sufficient uniformity as regards composition, constitution, age, spatial arrangement, or condition, to be distinguishable from adjacent communities, so forming a silvicultural or management entity (TFP)

stemflow: precipitation that is intercepted by vegetative cover and runs down the stems or major axes of such cover (TFP)

succession: unidirectional change in the composition of an ecosystem as the available competing organisms and especially the plants respond to and modify the environment (WNC)

successional stage: a recognizable condition of a plant community which occurs during its development to climax (Thomas 1979*)

suitability: the current capacity of an area to produce a specified crop **

tending: any operation carried out for the benefit of a forest crop, at any stage of its life; covers operations both on the crop itself (e.g., thinnings) and on competing vegetation, but not regeneration cuttings or site preparation (TFP)

thermal cover: cover used by animals to ameliorate effects of weather (Thomas 1979)

thermoneutral zone: an area where the ambient conditions do not trigger a metabolic response on the part of the occupying animal (Thomas 1979)

thicket: a dense growth of small trees, bushes, etc. (TFP*)

thinning: a felling made in an immature crop or stand in order primarily to accelerate diameter increment but also, by suitable selection, to improve the average form of the trees that remain (TFP*)

thinning-to-waste: see **non-commercial thinning**

understory: trees, shrubs, and herbaceous vegetation growing under the canopy formed by taller trees **

throughfall: all the precipitation reaching the forest floor minus the stemflow (i.e., canopy drip plus direct precipitation) (TFP)

tine: a pointed branch of an antler (WNC)

ungulate: any of the group (*Ungulata)* consisting of the hoofed mammals of which most are herbivorous and many are horned (WNC)

vascular plant: a plant having a specialized conducting system that includes xylem and phloem (WNC)

weeding: a cultural operation eliminating or suppressing undesirable vegetation, mainly herbaceous, during the seedling stage of a forest crop; done before the first cleaning to reduce competition with the seedling stage (TFP)

windrow: slash, brushwood, etc., concentrated along a line to clear the intervening ground between such lines (TFP*)

yarding: the operation of the initial transport of logs to a collecting point (i.e., transporting timber from stump to a yard or landing) (TFP*)

young growth: see **immature forest**

APPENDIX 4. COMMON AND SCIENTIFIC NAMES

PLANTS [1]

COMMON NAMES	SCIENTIFIC NAMES
alder, red	*Alnus rubra*
alpine-wintergreen	*Gaultheria humifusa*
alumroot, small-flowered	*Heuchera micrantha*
anemone, alpine	*Anemone drummondii*
arboreal lichens	*Alectoria* spp., *Bryoria* spp.
arbutus	*Arbutus menziesii*
arnicas	*Arnica* spp.
asphodel, sticky false	*Tofieldia glutinosa*
asters	*Aster* spp.
azalea, false	*Menziesia ferruginea*
baneberry	*Actaea rubra*
bedstraw, northern	*Galium boreale*
blackberry, trailing	*Rubus ursinus*
blueberry, Alaskan	*Vaccinium alaskaense*
blueberry, bog	*Vaccinium uliginosum*
blueberry, dwarf	*Vaccinium caespitosum*
blueberry, oval-leaved	*Vaccinium ovalifolium*
blue-eyed Mary, small-flowered	*Collinsia parviflora*
bluegrass, Kentucky	*Poa pratensis*
bog-laurel	*Kalmia microphylla* ssp. *occidentalis*
bog-orchid, white	*Platanthera dilatata*
bog-rosemary	*Andromeda polifolia*
bracken	*Pteridium aquilinum*
bramble, five-leaved	*Rubus pedatus*
brome, California	*Bromus carinatus*
broom, Scotch	*Cytisus scoparius*
bugbane, false	*Trautvetteria caroliniensis*
bunchberry	*Cornus canadensis*
burnet, great	*Sanguisorba officinalis*
burnet, Sitka	*Sanguisorba canadensis*
camas, common	*Camassia quamash*
cat's-ear, hairy	*Hypochaeris radicata*
chickweed, field	*Cerastium arvense*
coltsfoot, palmate	*Petasites palmatus*
cotton-grass, narrow-leaved	*Eriophorum angustifolium*
cottonwood, black	*Populus balsamifera* ssp. *trichocarpa*
cranberry, bog	*Vaccinium oxycoccos*
crowberry	*Empetrum nigrum*
currant, stink	*Ribes bracteosum*
death-camas, meadow	*Zigadenus venenosus*
deer-cabbage	*Fauria crista-galli*
devil's club	*Oplopanax horridus*
dogbane, spreading	*Apocynum androsaemifolium*
dogtail, hedgehog	*Cynosurus echinatus*
dogwood, red-osier	*Cornus sericea*

COMMON NAMES	SCIENTIFIC NAMES
Douglas-fir	*Pseudotsuga menziesii*
elderberry, red	*Sambucus racemosa*
fairybells, Hooker's	*Disporum hookeri*
false Solomon's-seal, star-flowered	*Smilacina stellata*
falsebox	*Paxistima myrsinites*
feathermoss, red-stemmed	*Pleurozium schreberi*
fern, deer	*Blechnum spicant*
fern, lady	*Athyrium filix-femina*
fern, maidenhair	*Adiantum pedatum*
fern, mountain holly	*Polystichum lonchitis*
fern, oak	*Gymnocarpium dryopteris*
fern, spiny wood	*Dryopteris assimilis*
fern, sword	*Polystichum munitum*
fir, amabilis	*Abies amabilis*
fir, grand	*Abies grandis*
fir, subalpine	*Abies lasiocarpa*
fireweed	*Epilobium angustifolium*
foamflower, one-leaved	*Tiarella unifoliata*
foamflower, three-leaved	*Tiarella trifoliata*
geranium, dovefoot	*Geranium molle*
goldthread, fern-leaved	*Coptis aspleniifolia*
grasses	*Gramineae* (spp. of this family)
grass-of-Parnassus, fringed	*Parnassia fimbriata*
hardhack	*Spiraea douglasii* ssp. *douglasii*
hedge-nettle	*Stachys* spp.
hellebore, Indian	*Veratrum viride*
hemlock, mountain	*Tsuga mertensiana*
hemlock, western	*Tsuga heterophylla*
horsetail	*Equisetum* spp.
horsetail, wood	*Equisetum sylvaticum*
huckleberry, black	*Vaccinium membranaceum*
huckleberry, red	*Vaccinium parvifolium*
juniper, common	*Juniperus communis*
kinnikinnick	*Arctostaphylos uva-ursi*
Labrador tea	*Ledum groenlandicum*
lichen	*Peltigera aphthosa*
lily, white fawn	*Erythronium oregonum*
lily-of-the-valley, false	*Maianthemum dilatatum*
louseworts	*Pedicularis* spp.
lupines	*Lupinus* spp.
maple, vine	*Acer circinatum*
maples	*Acer* spp.
marsh-marigolds	*Caltha* spp.

COMMON NAMES	SCIENTIFIC NAMES
montia, small-leaved	*Montia parvifolia*
moss	*Kindbergia praelonga*
moss	*Plagiomnium insigne*
moss, electrified cat's-tail	*Rhytidiadelphus triquetrus*
moss, grey frayed-cap	*Rhacomitrium canescens*
moss, lanky	*Rhytidiadelphus loreus*
moss, Oregon beaked	*Stokesiella oreganum*
moss, palm tree	*Leucolepis menziesii*
moss, pipecleaner	*Rhytidiopsis robusta*
moss, step	*Hylocomium splendens*
mountain-heather, pink	*Phyllodoce empetriformis*
mountain-heather, white	*Cassiope mertensiana*
ninebark, Pacific	*Physocarpus capitatus*
oatgrass, California	*Danthonia californica*
ocean-spray	*Holodiscus discolor*
onion, Hooker's	*Allium acuminatum*
Oregon-grape, dull	*Mahonia nervosa*
Oregon-grape, tall	*Mahonia aquifolium*
paintbrushes	*Castilleja* spp.
partridgefoot	*Luetkea pectinata*
pathfinder	*Adenocaulon bicolor*
pearly everlasting	*Anaphalis margaritacea*
piggy-back plant	*Tolmiea menziesii*
pine, lodgepole	*Pinus contorta* var. *latifolia*
prince's pine	*Chimaphila umbellata*
rattlesnake-plantain	*Goodyera oblongifolia*
redcedar, western	*Thuja plicata*
rhododendron, white-flowered	*Rhododendron albiflorum*
rose, baldhip	*Rosa gymnocarpa*
rushes	*Juncus* spp.

COMMON NAMES	SCIENTIFIC NAMES
salal	*Gaultheria shallon*
salmonberry	*Rubus spectabilis*
saskatoon	*Amelanchier alnifolia*
saxifrages	*Saxifraga* spp.
sea blush	*Plectritis congesta*
sedges	*Carex* spp.
single delight	*Moneses uniflora*
skunk cabbage	*Lysichiton americanum*
snowberry, trailing	*Symphoricarpos mollis*
sphagnum mosses	*Sphagnum* spp.
spruce, Engelmann	*Picea engelmannii*
spruce, Sitka	*Picea sitchensis*
strawberry, wild	*Fragaria virginiana*
sundew, round-leaved	*Drosera rotundifolia*
sweet gale	*Myrica gale*
tea-berry, western	*Gaultheria ovatifolia*
thimbleberry	*Rubus parviflorus*
twayblade, heart-leaved	*Listera cordata*
twinflower	*Linnaea borealis*
twistedstalk, clasping	*Streptopus amplexifolius*
twistedstalk, rosy	*Streptopus roseus*
valerian, Sitka	*Valeriana sitchensis*
vanilla-leaf	*Achlys triphylla*
vetches	*Vicia* spp.
violets	*Viola* spp.
wall-lettuce	*Mycelis muralis*
willow, Sitka	*Salix sitchensis*
willows	*Salix* spp.
yarrow	*Achillea millefolium*
yellow-cedar	*Chamaecyparis nootkatensis*

MAMMALS [2]

COMMON NAMES	SCIENTIFIC NAMES
black bear	*Ursus americanus*
Columbian black-tailed deer	*Odocoileus hemionus columbianus*
cougar	*Felis concolor*
Rocky Mountain elk	*Cervus elaphus nelsoni*
Rocky Mountain mule deer	*Odocoileus hemionus hemionus*
Roosevelt elk	*Cervus elaphus roosevelti*
Sitka deer	*Odocoileus hemionus sitkensis*
wolf	*Canis lupus*

PLANTS

SCIENTIFIC NAMES	COMMON NAMES
Abies amabilis	fir, amabilis
Abies grandis	fir, grand
Abies lasiocarpa	fir, subalpine
Acer circinatum	maple, vine
Acer spp.	maples
Achillea millefolium	yarrow
Achlys triphylla	vanilla-leaf
Actaea rubra	baneberry
Adenocaulon bicolor	pathfinder
Adiantum pedatum	fern, maidenhair
Alectoria spp., *Bryoria* spp.	arboreal lichens
Allium acuminatum	onion, Hooker's
Alnus rubra	alder, red
Amelanchier alnifolia	saskatoon
Anaphalis margaritacea	pearly everlasting
Andromeda polifolia	bog-rosemary
Anemone drummondii	anemone, alpine
Apocynum androsaemifolium	dogbane, spreading
Arbutus menziesii	arbutus
Arctostaphylos uva-ursi	kinnikinnick
Arnica spp.	arnicas
Aster spp.	asters
Athyrium filix-femina	fern, lady
Blechnum spicant	fern, deer
Bromus carinatus	brome, California
Caltha spp.	marsh-marigolds
Camassia quamash	camas, common
Carex spp.	sedges
Cassiope mertensiana	mountain-heather, white
Castilleja spp.	paintbrushes
Cerastium arvense	chickweed, field
Chamaecyparis nootkatensis	yellow-cedar
Chimaphila umbellata	prince's pine
Collinsia parviflora	blue-eyed Mary, small-flowered
Coptis aspleniifolia	goldthread, fern-leaved
Cornus canadensis	bunchberry
Cornus sericea	dogwood, red-osier
Cynosurus echinatus	dogtail, hedgehog
Cytisus scoparius	broom, Scotch
Danthonia californica	oatgrass, California
Disporum hookeri	fairybells, Hooker's
Drosera rotundifolia	sundew, round-leaved
Dryopteris assimilis	fern, spiny wood
Empetrum nigrum	crowberry
Epilobium angustifolium	fireweed
Equisetum spp.	horsetails
Equisetum sylvaticum	horsetail, wood
Eriophorum angustifolium	cotton-grass, narrow-leaved
Erythronium oregonum	lily, white fawn
Fauria crista-galli	deer-cabbage
Fragaria virginiana	strawberry, wild
Galium boreale	bedstraw, northern
Gaultheria humifusa	alpine-wintergreen
Gaultheria ovatifolia	tea-berry, western
Gaultheria shallon	salal
Geranium molle	geranium, dovefoot
Goodyera oblongifolia	rattlesnake-plantain
Gramineae (spp. of this family)	grasses
Gymnocarpium dryopteris	fern, oak
Heuchera micrantha	alumroot, small-flowered
Holodiscus discolor	ocean-spray
Hylocomium splendens	moss, step
Hypochaeris radicata	cat's-ear, hairy
Juncus spp.	rushes
Juniperus communis	juniper, common
Kalmia microphylla ssp. *occidentalis*	bog-laurel
Kindbergia praelonga	moss
Ledum groenlandicum	Labrador tea
Leucolepis menziesii	moss, palm tree
Linnaea borealis	twinflower
Listera cordata	twayblade, heart-leaved
Luetkea pectinata	partridgefoot
Lupinus spp.	lupines
Lysichiton americanum	skunk cabbage
Mahonia aquifolium	Oregon-grape, tall
Mahonia nervosa	Oregon-grape, dull
Maianthemum dilatatum	lily-of-the-valley, false
Menziesia ferruginea	azalea, false
Moneses uniflora	single delight
Montia parvifolia	montia, small-leaved
Mycelis muralis	wall-lettuce
Myrica gale	sweet gale
Oplopanax horridus	devil's club
Parnassia fimbriata	grass-of-Parnassus, fringed
Paxistima myrsinites	falsebox
Pedicularis spp.	louseworts
Peltigera aphthosa	lichen
Petasites palmatus	coltsfoot, palmate
Phyllodoce empetriformis	mountain-heather, pink
Physocarpus capitatus	ninebark, Pacific
Picea engelmannii	spruce, Engelmann
Picea sitchensis	spruce, Sitka
Pinus contorta var. *latifolia*	pine, lodgepole
Plagiomnium insigne	moss
Platanthera dilatata	bog-orchid, white
Plectritis congesta	sea blush
Pleurozium schreberi	feathermoss, red-stemmed

SCIENTIFIC NAMES	COMMON NAMES
Poa pratensis	bluegrass, Kentucky
Polystichum lonchitis	fern, mountain holly
Polystichum munitum	fern, sword
Populus balsamifera ssp. *trichocarpa*	cottonwood, black
Pseudotsuga menziesii	Douglas-fir
Pteridium aquilinum	bracken
Rhacomitrium canescens	moss, grey frayed-cap
Rhododendron albiflorum	rhododendron, white-flowered
Rhytidiadelphus loreus	moss, lanky
Rhytidiadelphus triquetrus	moss, electrified cat's-tail
Rhytidiopsis robusta	moss, pipecleaner
Ribes bracteosum	currant, stink
Rosa gymnocarpa	rose, baldhip
Rubus parviflorus	thimbleberry
Rubus pedatus	bramble, five-leaved
Rubus spectabilis	salmonberry
Rubus ursinus	blackberry, trailing
Salix sitchensis	willow, Sitka
Salix spp.	willows
Sambucus racemosa	elderberry, red
Sanguisorba canadensis	burnet, Sitka
Sanguisorba officinalis	burnet, great
Saxifraga spp.	saxifrages
Smilacina stellata	false Solomon's-seal, star-flowered
Sphagnum spp.	sphagnum mosses
Spiraea douglasii ssp. *douglasii*	hardhack

SCIENTIFIC NAMES	COMMON NAMES
Stachys spp.	hedge-nettles
Stokesiella oreganum	moss, Oregon beaked
Streptopus amplexifolius	twistedstalk, clasping
Streptopus roseus	twistedstalk, rosy
Symphoricarpos mollis	snowberry, trailing
Thuja plicata	redcedar, western
Tiarella trifoliata	foamflower, three-leaved
Tiarella unifoliata	foamflower, one-leaved
Tofieldia glutinosa	asphodel, sticky false
Tolmiea menziesii	piggy-back plant
Trautvetteria caroliniensis	bugbane, false
Tsuga heterophylla	hemlock, western
Tsuga mertensiana	hemlock, mountain
Vaccinium alaskaense	blueberry, Alaskan
Vaccinium caespitosum	blueberry, dwarf
Vaccinium membranaceum	huckleberry, black
Vaccinium ovalifolium	blueberry, oval-leaved
Vaccinium oxycoccos	cranberry, bog
Vaccinium parvifolium	huckleberry, red
Vaccinium uliginosum	blueberry, bog
Valeriana sitchensis	valerian, Sitka
Veratrum viride	hellebore, Indian
Vicia spp.	vetches
Viola spp.	violets
Zigadenus venenosus	death-camas, meadow

MAMMALS

SCIENTIFIC NAMES	COMMON NAMES
Canis lupus	wolf
Cervus elaphus nelsoni	Rocky Mountain elk
Cervus elaphus roosevelti	Roosevelt elk
Felis concolor	cougar
Odocoileus hemionus hemionus	Rocky Mountain mule deer
Odocoileus hemionus columbianus	Columbian black-tailed deer
Odocoileus hemionus sitkensis	Sitka deer
Ursus americanus	black bear

Sources:

[1] Meidinger, D. (compiler). 1988. Recommended vernacular names for common plants of British Columbia. B.C. Min. of For. Lands. Research Rep. Revised.

[2] Cowan, I. M. and C.J. Guiguet. 1978. The mammals of British Columbia. B.C. Provincial Museum Handb. No. 11, Victoria, B.C.

APPENDIX 5. FOREST COVER MAP LEGEND

I. FOREST LAND

A. FOREST LAND (FORESTED)

SPECIES COMPOSITION

Species are listed in their order of predominance. Major species are listed first followed by minor species in brackets.

SPECIES SYMBOLS

The standard symbols for some species are abbreviated, e.g. Fd is shown as F; Cw is shown as C̲.

F	-Douglas-fir	*Pl*	-Lodgepole pine
C	-Western redcedar	*Py*	-Yellow pine
H	-Hemlock	*L*	-Larch
B	-Balsam (True fir)	*Ct*	-Cottonwood
S	-Spruce	*D*	-Red alder
Sb	-Black spruce	*Mb*	-Broadleaf maple
Cy	-Yellow cedar	*Bi*	-Birch
Pw	-Western white pine	*A*	-Aspen
Pa	-Whitebark pine		

EXAMPLE OF A FOREST COVER LABEL

SB(Pl)
210P2

SB(Pl)	-SPECIES COMPOSITION
2	-AGE CLASS CODE
1	-HEIGHT CLASS CODE
0	-STOCKING CLASS CODE
P	-SITE CLASS CODE
2	-CROWN CLOSURE CLASS CODE

FOREST LAND (UNPRODUCTIVE)

Ⱥ + Forest description

NON-FOREST LAND

Ⱥ	-Alpine	⚘	-Swamp or muskeg
R	-Rock	∽	Slide

AGE CLASS CODES

CODE	LIMITS (years)
1	1-20
2	21-40
3	41-60
4	61-80
5	81-100
6	101-120
7	121-140
8	141-250
9	251+

HEIGHT CLASS CODES

CODE	LIMITS (metres)
1	0-10.4
2	10.5-19.4
3	19.5-28.4
4	28.5-37.4
5	37.5-46.4
6	46.5-55.4
7	55.5-64.4
8	64.5+

SITE CLASS CODES

CODE	SITE
L	Low
P	Poor
M	Medium
G	Good

STOCKING CLASS CODES

CODE		APPLIES TO	LIMITS No. of trees/hectare, d.b.h. limits
0		all immature *	N.A.
1		all mature *	≥76/ ha, 27.5 cm+ d.b.h.
2		all mature	<76/ ha, 27.5 cm+ d.b.h.
Subdivision of 2	*3*	mature, with leading species *Pl*	≥311/ ha, 17.5 cm+ d.b.h. and ≥50% of stems 7.5 cm+ d.b.h. are ≥12.5 cm d.b.h.
	4		<311/ ha, 17.5 cm+ d.b.h., or ≥311/ ha, 17.5 cm+ d.b.h. and <50% of stems 7.5 cm+ d.b.h. are ≥12.5 cm d.b.h.
R		immature; mature	stands disturbed 26-75% by area or volume

*	All deciduous species; *Pl*; *Pa*	All coniferous species except *Pl* and *Pa*
Immature	1-80 yrs.	1-120 yrs.
Mature	≥81 yrs.	≥121 yrs.

CROWN CLOSURE CLASS CODES

CODE	LIMITS (percentage)
0	0-5
1	6-15
2	16-25
3	26-35
4	36-45
5	46-55
6	56-65
7	66-75
8	76-85
9	86-95
10	96-100

PLANTS

SCIENTIFIC NAMES	COMMON NAMES
Abies amabilis	fir, amabilis
Abies grandis	fir, grand
Abies lasiocarpa	fir, subalpine
Acer circinatum	maple, vine
Acer spp.	maples
Achillea millefolium	yarrow
Achlys triphylla	vanilla-leaf
Actaea rubra	baneberry
Adenocaulon bicolor	pathfinder
Adiantum pedatum	fern, maidenhair
Alectoria spp., *Bryoria* spp.	arboreal lichens
Allium acuminatum	onion, Hooker's
Alnus rubra	alder, red
Amelanchier alnifolia	saskatoon
Anaphalis margaritacea	pearly everlasting
Andromeda polifolia	bog-rosemary
Anemone drummondii	anemone, alpine
Apocynum androsaemifolium	dogbane, spreading
Arbutus menziesii	arbutus
Arctostaphylos uva-ursi	kinnikinnick
Arnica spp.	arnicas
Aster spp.	asters
Athyrium filix-femina	fern, lady
Blechnum spicant	fern, deer
Bromus carinatus	brome, California
Caltha spp.	marsh-marigolds
Camassia quamash	camas, common
Carex spp.	sedges
Cassiope mertensiana	mountain-heather, white
Castilleja spp.	paintbrushes
Cerastium arvense	chickweed, field
Chamaecyparis nootkatensis	yellow-cedar
Chimaphila umbellata	prince's pine
Collinsia parviflora	blue-eyed Mary, small-flowered
Coptis aspleniifolia	goldthread, fern-leaved
Cornus canadensis	bunchberry
Cornus sericea	dogwood, red-osier
Cynosurus echinatus	dogtail, hedgehog
Cytisus scoparius	broom, Scotch
Danthonia californica	oatgrass, California
Disporum hookeri	fairybells, Hooker's
Drosera rotundifolia	sundew, round-leaved
Dryopteris assimilis	fern, spiny wood
Empetrum nigrum	crowberry
Epilobium angustifolium	fireweed
Equisetum spp.	horsetails
Equisetum sylvaticum	horsetail, wood
Eriophorum angustifolium	cotton-grass, narrow-leaved
Erythronium oregonum	lily, white fawn
Fauria crista-galli	deer-cabbage
Fragaria virginiana	strawberry, wild
Galium boreale	bedstraw, northern
Gaultheria humifusa	alpine-wintergreen
Gaultheria ovatifolia	tea-berry, western
Gaultheria shallon	salal
Geranium molle	geranium, dovefoot
Goodyera oblongifolia	rattlesnake-plantain
Gramineae (spp. of this family)	grasses
Gymnocarpium dryopteris	fern, oak
Heuchera micrantha	alumroot, small-flowered
Holodiscus discolor	ocean-spray
Hylocomium splendens	moss, step
Hypochaeris radicata	cat's-ear, hairy
Juncus spp.	rushes
Juniperus communis	juniper, common
Kalmia microphylla ssp. *occidentalis*	bog-laurel
Kindbergia praelonga	moss
Ledum groenlandicum	Labrador tea
Leucolepis menziesii	moss, palm tree
Linnaea borealis	twinflower
Listera cordata	twayblade, heart-leaved
Luetkea pectinata	partridgefoot
Lupinus spp.	lupines
Lysichiton americanum	skunk cabbage
Mahonia aquifolium	Oregon-grape, tall
Mahonia nervosa	Oregon-grape, dull
Maianthemum dilatatum	lily-of-the-valley, false
Menziesia ferruginea	azalea, false
Moneses uniflora	single delight
Montia parvifolia	montia, small-leaved
Mycelis muralis	wall-lettuce
Myrica gale	sweet gale
Oplopanax horridus	devil's club
Parnassia fimbriata	grass-of-Parnassus, fringed
Paxistima myrsinites	falsebox
Pedicularis spp.	louseworts
Peltigera aphthosa	lichen
Petasites palmatus	coltsfoot, palmate
Phyllodoce empetriformis	mountain-heather, pink
Physocarpus capitatus	ninebark, Pacific
Picea engelmannii	spruce, Engelmann
Picea sitchensis	spruce, Sitka
Pinus contorta var. *latifolia*	pine, lodgepole
Plagiomnium insigne	moss
Platanthera dilatata	bog-orchid, white
Plectritis congesta	sea blush
Pleurozium schreberi	feathermoss, red-stemmed

SCIENTIFIC NAMES	COMMON NAMES
Poa pratensis	bluegrass, Kentucky
Polystichum lonchitis	fern, mountain holly
Polystichum munitum	fern, sword
Populus balsamifera ssp. *trichocarpa*	cottonwood, black
Pseudotsuga menziesii	Douglas-fir
Pteridium aquilinum	bracken
Rhacomitrium canescens	moss, grey frayed-cap
Rhododendron albiflorum	rhododendron, white-flowered
Rhytidiadelphus loreus	moss, lanky
Rhytidiadelphus triquetrus	moss, electrified cat's-tail
Rhytidiopsis robusta	moss, pipecleaner
Ribes bracteosum	currant, stink
Rosa gymnocarpa	rose, baldhip
Rubus parviflorus	thimbleberry
Rubus pedatus	bramble, five-leaved
Rubus spectabilis	salmonberry
Rubus ursinus	blackberry, trailing
Salix sitchensis	willow, Sitka
Salix spp.	willows
Sambucus racemosa	elderberry, red
Sanguisorba canadensis	burnet, Sitka
Sanguisorba officinalis	burnet, great
Saxifraga spp.	saxifrages
Smilacina stellata	false Solomon's-seal, star-flowered
Sphagnum spp.	sphagnum mosses
Spiraea douglasii ssp. *douglasii*	hardhack

SCIENTIFIC NAMES	COMMON NAMES
Stachys spp.	hedge-nettles
Stokesiella oreganum	moss, Oregon beaked
Streptopus amplexifolius	twistedstalk, clasping
Streptopus roseus	twistedstalk, rosy
Symphoricarpos mollis	snowberry, trailing
Thuja plicata	redcedar, western
Tiarella trifoliata	foamflower, three-leaved
Tiarella unifoliata	foamflower, one-leaved
Tofieldia glutinosa	asphodel, sticky false
Tolmiea menziesii	piggy-back plant
Trautvetteria caroliniensis	bugbane, false
Tsuga heterophylla	hemlock, western
Tsuga mertensiana	hemlock, mountain
Vaccinium alaskaense	blueberry, Alaskan
Vaccinium caespitosum	blueberry, dwarf
Vaccinium membranaceum	huckleberry, black
Vaccinium ovalifolium	blueberry, oval-leaved
Vaccinium oxycoccos	cranberry, bog
Vaccinium parvifolium	huckleberry, red
Vaccinium uliginosum	blueberry, bog
Valeriana sitchensis	valerian, Sitka
Veratrum viride	hellebore, Indian
Vicia spp.	vetches
Viola spp.	violets
Zigadenus venenosus	death-camas, meadow

MAMMALS

SCIENTIFIC NAMES	COMMON NAMES
Canis lupus	wolf
Cervus elaphus nelsoni	Rocky Mountain elk
Cervus elaphus roosevelti	Roosevelt elk
Felis concolor	cougar
Odocoileus hemionus hemionus	Rocky Mountain mule deer
Odocoileus hemionus columbianus	Columbian black-tailed deer
Odocoileus hemionus sitkensis	Sitka deer
Ursus americanus	black bear

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APPENDIX 5. FOREST COVER MAP LEGEND

I. FOREST LAND

A. FOREST LAND (FORESTED)

SPECIES COMPOSITION

Species are listed in their order of predominance. Major species are listed first followed by minor species in brackets.

SPECIES SYMBOLS

The standard symbols for some species are abbreviated, e.g. Fd is shown as F; Cw is shown as C.

F -Douglas-fir
C -Western redcedar
H -Hemlock
B -Balsam (True fir)
S -Spruce
Sb -Black spruce
Cy -Yellow cedar
Pw -Western white pine
Pa -Whitebark pine
Pl -Lodgepole pine
Py -Yellow pine
L -Larch
Ct -Cottonwood
D -Red alder
Mb -Broadleaf maple
Bi -Birch
A -Aspen

EXAMPLE OF A FOREST COVER LABEL

SB(Pl)
210P2

SB(Pl)	-SPECIES COMPOSITION
2	-AGE CLASS CODE
1	-HEIGHT CLASS CODE
0	-STOCKING CLASS CODE
P	-SITE CLASS CODE
2	-CROWN CLOSURE CLASS CODE

FOREST LAND (UNPRODUCTIVE)

₳ + Forest description

NON-FOREST LAND

₳ -Alpine
R -Rock
☼ -Swamp or muskeg
.S Slide

AGE CLASS CODES

CODE	LIMITS (years)
1	1-20
2	21-40
3	41-60
4	61-80
5	81-100
6	101-120
7	121-140
8	141-250
9	251+

HEIGHT CLASS CODES

CODE	LIMITS (metres)
1	0-10.4
2	10.5-19.4
3	19.5-28.4
4	28.5-37.4
5	37.5-46.4
6	46.5-55.4
7	55.5-64.4
8	64.5+

SITE CLASS CODES

CODE	SITE
L	Low
P	Poor
M	Medium
G	Good

STOCKING CLASS CODES

CODE		APPLIES TO	LIMITS No. of trees/hectare, d.b.h. limits
0		all immature *	N.A.
1		all mature *	≥76/ ha, 27.5 cm+ d.b.h.
2		all mature	<76/ ha, 27.5 cm+ d.b.h.
Subdivision of 2	*3*	mature, with leading species *Pl*	≥311/ ha, 17.5 cm+ d.b.h. and ≥50% of stems 7.5 cm+ d.b.h. are ≥12.5 cm d.b.h.
	4		<311/ ha, 17.5 cm+ d.b.h., or ≥311/ ha, 17.5 cm+ d.b.h. and <50% of stems 7.5 cm+ d.b.h. are ≥12.5 cm d.b.h.
R		immature; mature	stands disturbed 26-75% by area or volume

*	All deciduous species; *Pl* ; *Pa*	All coniferous species except *Pl* and *Pa*
Immature	1-80 yrs.	1-120 yrs.
Mature	≥81 yrs.	≥121 yrs.

CROWN CLOSURE CLASS CODES

CODE	LIMITS (percentage)
0	0-5
1	6-15
2	16-25
3	26-35
4	36-45
5	46-55
6	56-65
7	66-75
8	76-85
9	86-95
10	96-100

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